"Old Iranian Calendars," by W. Hartner, from *Cambridge History of Iran* (London, 1985), Volume 2, Chapter 16, pp. 714-791, with Bibliography.

CHAPTER 16

OLD IRANIAN CALENDARS

PART I. ELEMENTS OF THE CALENDAR. DEFINITIONS

I. 1. The number of calendars in use among the many civilizations of our globe, past and present, is legion. However, notwithstanding their diversity they all have, or at one time had, two main elements in common: a lunar serving to define smaller, not strictly equal, units of time, and a solar measuring the "year", i.e., the cyclical recurrence of the seasons. Evidently, the latter alone is of importance to agriculture and thus meets the practical needs of a higher stage of civilization, while the former, being of little practical value, could in theory have been dispensed with as soon as a sedentary community had found means and ways to establish a primitive solar calendar. But in practice, such a radical break with tradition occurred only in exceptional cases.

In point of fact, of all calendars known in history there are only four that were – or at least were intended to be – oriented by the Sun alone: the Egyptian, the Achaemenian Later Avestan, the Julian-Gregorian and that developed by the central-American Mayas and later adopted by the neighbouring Aztecs. But even in the Egyptian and in the Julian calendars, as still in our modern Gregorian, the lunar element is not suppressed completely. As is well-known, it plays a decisive role in the determination of Easter, which fact bears witness to the importance of the religious element even in the most recent phase of a multi-millenary evolution. For at all times and places we find that calendar and religion form an inseparable unity.

The periodically changing aspect of the Moon, its "phases", comprising approximately 30 days, must needs have attracted man's attention since the remotest times, numberless millennia before the dawn of history. These lunar phases, it will be well to note, are the most striking cyclical astronomical phenomenon that lends itself to direct observation, being at the same time independent of the place occupied by the observer. Hence, evidently, the Moon was always considered the time indicator *par excellence*. It maintained this place of honour even after practical reasons had caused the early settlers to look for means to

determine significant dates of the solar year that would indicate the times for sowing and harvesting as well as other term-days of importance to agriculture or to other needs of the community.

I. 2. In this context I deliberately avoid speaking of the "determination of the length of the year" or of the "length of the month", because it is certain that the habit of counting days so as to establish an algebraic relation between the month and the year belongs to a relatively late stage of evolution. For the following demonstrations, however, it will be useful to start with a few numerical data.

The motion of the two great luminaries is irregular. The actual length of the lunar month ("lunation") varies from one revolution to the other, and the same, though in a lesser degree, is true of the length of the year. What is essential to all astronomical, in particular calendrical, considerations, is the determination of the *mean* duration of the periods concerned.

The modern value for the mean length of the lunation is 29.53059 days. It was known with nearly the same accuracy already in Babylonian times (middle of 1st millennium B.C.). As for the year, the matter is more complicated since we have to distinguish between two alternatives. The *sidereal* year, defined as the lapse of time between two consecutive conjunctions of the Sun with an appropriately chosen fixed star, say Regulus (α Leonis), has a length of 365.25636 days, while the *tropical* year, measuring the time between consecutive conjunctions with the *vernal point* (intersecting point of ecliptic and equator) is slightly shorter: 365.24220 days.

It is true, the difference between the two, resulting from the *precession of the equinoxes*, is too small to make itself felt in the course of only a few generations, but it becomes perceptible over longer periods of time. To give an example, it amounted to *c.* 50 days from the time of the early settlers of Susa and Persepolis (*c.* 4000 B.C.) to the accession of the Achaemenian rulers. This implies that a sidereal phenomenon (e.g. the heliacal rising of a certain star near the ecliptic) occurring in 4000 B.C. at spring equinox (21 March according to the Gregorian Calendar)[1] will take place in Achaemenian time on or about 10 May.

[1] In Parts I–III (pp. 714–756) of the present study, all dates will be expressed in terms of the Gregorian Calendar (recomputed) because only this permits us to recognize directly the season, i.e. the tropical date at which an astronomical phenomenon occurs. In Part IV (pp. 756–781), unless indicated expressly, Julian dates will be given. [A succinct and more technical presentation of the essence of this chapter was given by Willy Hartner in his article "The Young Avestan and

RISING AND SETTING AZIMUTHS OF THE SUN

I. 3. From observations made at one and the same place of the Earth and stretching over lengthy periods of time, the regular recurrence of various astronomical phenomena can easily be recognized. Thus it will soon become evident that the Sun's rising and setting points ("azimuths", i.e. angular distances from the East and West points of the horizon)[1] vary with the seasons. At spring equinox the Sun rises at the East point of the horizon and sets at its West point. Subsequently, these points gradually recede from E and W respectively, in a northerly direction until, about the time of summer solstice, they reach a maximum distance and come to a standstill. Thereafter, they proceed in the opposite direction. Their second passing through E and W marks autumn equinox. At winter solstice they reach a maximum southern distance and have a second standstill. After this they again change direction until they occupy anew the E and W points, whereafter the phenomena described recur in the same sequence.

In this way, theoretically, the solar year as a whole as well as any particular solar date of interest (such as the time of sowing or harvesting) can be determined by marking down appropriate rising and setting points of the Sun along the horizon, without recourse to other kinds of astronomical observations. In practice, however, this "azimuth method" is encountered only in exceptional cases,[2] for the obvious

Babylonian Calendars and the Antecedents of Precession", *Journal for the History of Astronomy* x (1979), pp. 1–22, written after and partly arising from his contribution to the present volume. It is not Hartner but the present Editor who, after the article had appeared, replaced throughout the chapter the phrase "Young Avestan calendar", commonly used also by Hartner's predecessors, with "Later Avestan calendar". This was done to guard against possible source confusion arising in the minds of readers from the fact that not only the Avestan evidence on the "Young Avestan calendar", but also the Avestan evidence on the "Old Avestan calendar" is found exclusively in texts written in what is termed the "Younger Avestan" language for the purpose of distinguishing it from the "Gāthic Avestan" language; in the latter, believed by some scholars (wrongly, in the Editor's opinion) to be "older" than the "Younger Avestan" language (which of course is why the "Younger" has come to be so termed), no calendrical information whatever has come down to us. The use of "Old" and "Later" in the present discussion of the Avestan calendars thus safely steers clear of the linguistic distinction between "Gāthic" and "Younger". Concurrently, Avestan (both Gāthic and Younger) being one of the only two Old Iranian languages in which texts have survived, the Editor thought it proper, wherever in this chapter Hartner used the phrase "Old-Iranian calendar", to replace it with "Old Persian calendar", since that is a calendar exclusively attested in Old Persian sources (including the ones written in Elamite language, on which see above). Ed.]

[1] In antiquity the azimuths were counted from E and W towards N and S, in modern astronomy they are counted from S over E or W, respectively, to N.

[2] Thus in high northern latitudes, where the rising and setting points cover large parts of the horizon, while for Persepolis the variation amounts only to *c.* 56° (28° north and south of the E and W points).

reason that the daily variation of the azimuth – even in the neighbourhood of the E and W points, where it is fastest – is much too small to ascertain reliable results.

STAR PHASES: HELIACAL RISINGS AND SETTINGS, ACRONYCHAL RISINGS AND COSMICAL SETTINGS

I. 4. The method actually used in antiquity is based on an entirely different principle, which may be described as follows.[1] In the course of a year the Sun travels along a circle inclined to the equator through the constellations of the ecliptic. Now, for obvious reasons, its *conjunction* with the stars it passes by cannot be observed directly. What is observable, however, is the first rising before sunrise of a star with which the Sun has been in conjunction shortly before. This phenomenon, called the star's *heliacal rising*, is a very striking one. On a certain day of the year, after a period of invisibility whose duration depends mainly on its distance from the ecliptic, the star reappears for the first time: at morning-dawn, it rises over the horizon, remains visible for a very short time, and then disappears again in the rays of the rising Sun. During the subsequent days and weeks, due to its increasing distance from the Sun, the period of its visibility before sunrise will steadily increase. After a certain time, the star culminates at dawn. Thereafter it will be found nearer and nearer the western horizon until one day it sets at sunrise. This *true cosmical setting*, evidently, is not observable. We have to wait another couple of weeks until the star's setting becomes visible before sunrise (*apparent cosmical setting*).

The corresponding phenomena, referring to sunset and evening-twilight, are analogous. On a certain day, the star has its last visible rising after sunset (*apparent acronychal rising*). The *true acronychal rising*, occurring a number of days later, is not observable. The next phenomenon of importance is the star's culmination at twilight. Thereafter the distance between the star and the Sun decreases until one day the star has its last visible setting at twilight (*heliacal setting*); it marks the beginning of the period of invisibility, which ends with the new heliacal rising.

Thus the following six phenomena are suited to fix solar dates during the course of the year:

[1] For further details, see W. Hartner, "The Earliest History of the Constellations in the Near East and the Motif of the Lion–Bull Combat", *JNES* XXIV (1965), pp. 1–16, reprinted in W. Hartner, *Oriens–Occidens* (Hildesheim, 1968), pp. 227–59; see in particular pp. 5ff. of *JNES* (231 ff. of *Oriens–Occidens*).

the heliacal rising of a star, i.e. its first visible rising at dawn;
the star's culmination at dawn;
the cosmical[1] setting of a star, i.e. its first visible setting at dawn;
the acronychal[1] rising of a star, i.e. its last visible rising at twilight;
the star's culmination at twilight;
the heliacal setting of a star, i.e. its last visible setting at twilight.

I. 5. A few historical examples will illustrate the wide diffusion of this method:

a. Hesiod's *Works and Days* (vv. 383–4):

> *Πληιάδων Ἀτλαγενέων ἐπιτελλομενάων*
> *ἄρχεσθ' ἀμήτου, ἀρότοιο δὲ δυσομενάων.*
>
> When the Pleiades, Atlas' daughters, rise,
> begin your harvest, and (begin to) plough when they set.

Here ἐπιτέλλεσθαι refers to the heliacal rising (*c.* 15 May at Hesiod's time), and δύεσθαι to the cosmical setting (10 November).

b. The Greek Calendar (παράπηγμα) attributed to Geminos (1st century B.C.), but dating actually from *c.* 200 B.C.,[2] divides the year schematically into twelve months of approximately equal length, starting at summer solstice. There we read that on the 1st day of the tenth month (21 March), the Band of the Fishes (Pisces) rises heliacally; it is followed by Aries on the 3rd. On the 10th the Pleiades set heliacally, whereupon they remain invisible for 40 days. On the 21st the heliacal setting of the Hyades (the Bull's Head) is listed. On the 11th day of the eleventh month Scorpius starts setting heliacally; on the 13th occurs the reappearance (heliacal rising) of the Pleiades, etc.

A similar calendar was composed by Ptolemy;[3] it operates with the same constellations.

c. The Arabic–Latin Cordova Calendar[4] is based on the same principle, preference being given to the heliacal settings (*anwāʾ*) of the 28 lunar

[1] Since only the apparent, not the true, phenomena are observable, the epithet "apparent" in the case of cosmical settings and acronychal risings is dropped here; the word "heliacal" always indicates the apparent phenomenon.

[2] See Geminus, *Elementa Astronomiae*, ed. K. Manitius (Leipzig, 1898), pp. 210–33.

[3] *Φάσεις ἀπλανῶν ἀστέρων*, in *C. Ptolemaei Opera Omnia* II: *Opera Astronomica Minora*, ed. J. L. Heiberg (Leipzig, 1907), pp. 1–67.

[4] See *Le calendrier de Cordoue de l'année 961*, ed. R. Dozy (Leiden, 1873); new edition with French translation by Ch. Pellat (Leiden, 1961).

mansions. As noted by R. B. Serjeant the method is still in use among the fishermen in Baḥrain.[1]

d. The first Babylonian tablet of $^{\text{mul}}$APIN[2] is a perfect analogon to the Greek calendars. As in Geminos' *Parapegma*, the year is divided into 12 approximately equal parts ("solar months"), its first day (I 1), for the probable time of composition (1300–1000 B.C.), falling on a date near the vernal equinox. The tablet lists the heliacal risings (other phenomena are not mentioned) of 36 stars, as illustrated in the following:[3]

I 1 (21 March),	LU.HUN.GA ("the hired labourer") = Aries
I 20 (9 April),	GAM = Capella
II 1 (20 April),	MUL.MUL = Pleiades
II 20 (9 May),	*is li-e* ("the Bull's Jaw") = Taurus (Aldebaran and Hyades)
III 10 (29 May),	SIBA.ZI.AN.NA = Orion, and MAŠ.TAB.BA.GAL.GAL = Gemini (Castor and Pollux)
IV 5 (24 June),	MAŠ.TAB.BA.TUR.TUR = ι, ν Gem., and AL.LUL = Prokyon
IV 15 (4 July),	KAK.SI.DI = Sirius, MUŠ = Hydra, and UR.GU.LA = Leo
V 5 (24 July),	BAN = "The Bow" (ξ, k Puppis, η, χ, ϵ, σ, δ, τ Can. maj.), and LUGAL (*šarru*) = Regulus
: : : : :	
VIII 5 (23 Oct.),	GIR.TAB = Scorpius
VIII 15 (2 Nov.),	UZA = Lyra, and GAB.GIR.TAB = α Scorpii (Antares)
: : : : :	
XI 5 (23 Jan.),	GU.LA = Aquarius, IKU = "Pegasus Rectangle", and LU.LIM = Cassiopeia
XI 25 (13 Febr.),	Anunītu = north-eastern part of Pisces
XII 15 (5 March),	KU_6 = Piscis austrinus, and ŠU.GI = Perseus

In Egypt, the same principle is prevalent in the so-called "diagonal calendars" based on the 36 "decans", i.e. constellations near the ecliptic, whose successive heliacal risings mark the beginnings of the 36 ten-day periods of the year.[4] The analogy to the $^{\text{mul}}$APIN tablet,

[1] "Fisher-Folk and Fish-Traps in al-Baḥrain", *BSOAS* XXXI (1968), pp. 486–514.

[2] Cf. B. L. van der Waerden, "Babylonian Astronomy II. The Thirty-Six Stars", *JNES* VIII (1949), pp. 6–26; see p. 20, Table 3, and W. Hartner, "The Earliest History", pp. 5ff.

[3] Cf. B. L. van der Waerden, *Anfänge der Astronomie* (Groningen, [1966]), pp. 70ff., and Hartner, "The Earliest History", p. 7.

[4] Cf. B. L. van der Waerden, pp. 17ff.

which operates equally with 36 stars or constellations, is striking, but our scanty knowledge of Egyptian constellations does not permit us to decide whether or not this similarity is accidental.

Also in China the system of annual risings, settings and culminations was widely used, as attested by early calendars such as the *Hsia hsiao-chêng* contained in the *Li-chi* ("Book of Rites") or the *Yüeh-ling* forming the basis of the first twelve chapters of the *Lü-shih ch'un-ch'iu* ("Master Lü's Spring and Autumn Annals").[1]

PART II. THE CALENDAR IN PREHISTORIC IRAN AND MESOPOTAMIA

II. 1. On the basis of the above indications it is possible to form a fairly clear idea of the essential features of the prehistoric Iranian calendar. Since the earliest settlers, as soon as they had reached the stage of developed agricultural activity about or before 4000 B.C., needed a calendar indicating solar dates, they must of necessity have taken recourse to the very same principle which we find prevalent, 2,000 years later, at the dawn of history. This *a priori* statement is fully confirmed by an overwhelming number of pictorial representations of constellations whose calendrical significance is beyond doubt.

A glance at diagram 1,[2] showing the celestial sphere as it presented itself to man's eye about 4000 B.C.,[3] will teach us which of the constellations forming the later "zodiac" can be expected to have served as "calendar asterisms". About the pole, situated at that time in a starless region, four concentric circles are drawn. The innermost comprises the circumpolar stars for a northern latitude of 30° (Persepolis and, approximately, Susa and Ur). Then follow the northern tropic, the equator and the southern tropic; the outermost circle, again for the latitude mentioned, indicates the limit of visibility near the south point of the horizon. The brilliant star Canopus which, due to the precession of the equinoxes, in the course of the ensuing millennia rose higher and

[1] See J. Needham, *Science and Civilisation in China* III (Cambridge, 1959), pp. 194f., and W. Hartner, "Die astronomischen Angaben des Hia Siau Dscheng", in R. Wilhelm, *Li Gi, Das Buch der Sitte* (Jena, 1930), pp. 413ff.

[2] After Hartner, "The Earliest History"; for further information I refer the reader to this article.

[3] On two occasions encircled asterisks and the words "η Tauri -500" and "Regulus -500" are found (near AR = 20° and 117° respectively). They indicate the positions of the named stars about the time of the conquest of Egypt by Cambyses (525 B.C.) and of Darius the Great, under whose reign the Later Avestan calendar was adopted by the Iranians.

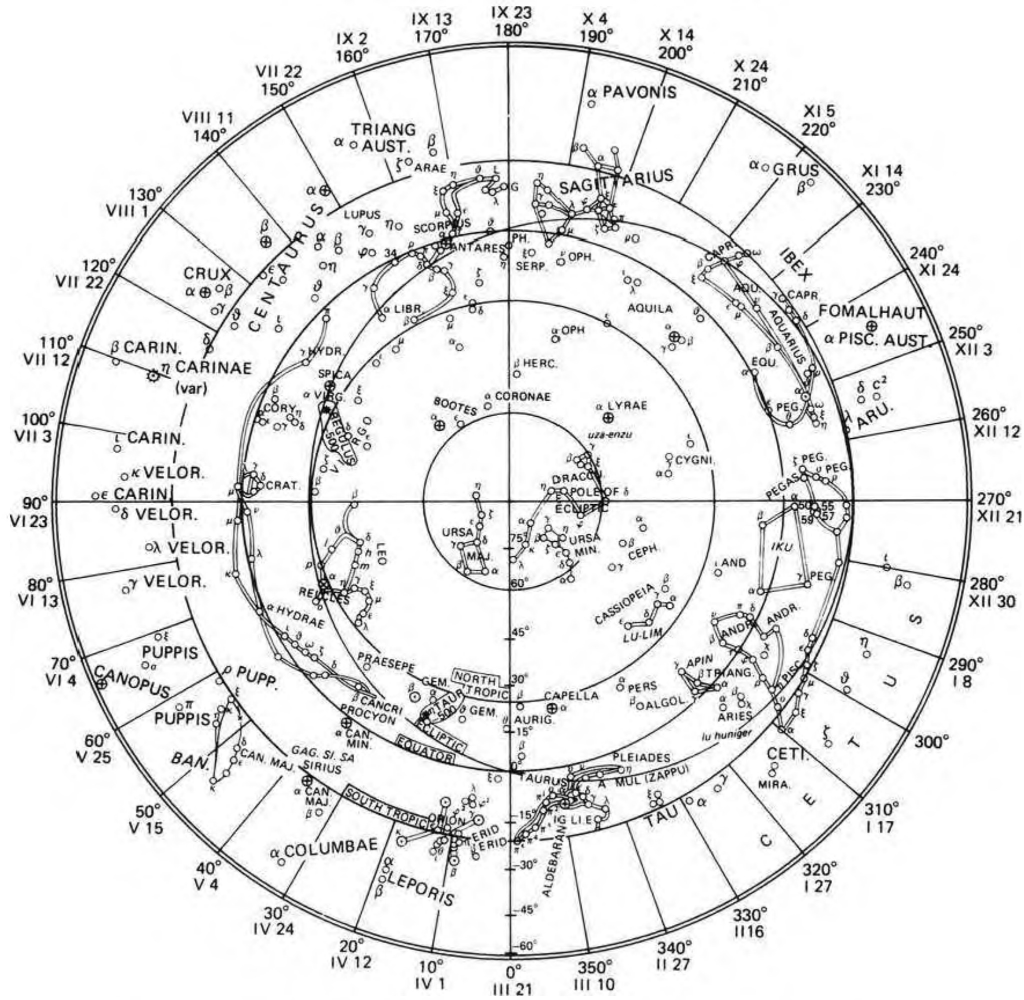


Diagram 1. The celestial sphere at 4000 B.C. (Akkadian star names italicized).

higher above the horizon, was at the limit of observability at that remote time.

The path of the Sun, the ecliptic, is the oblique circle which cuts the equator at two diametrically opposite points, at right ascensions (AR)[1] 0° and 180° and touches the tropics at AR 90° and 270° respectively. At vernal equinox the Sun occupies the vernal point (AR $= 0^\circ$); at

[1] The right ascensions are angles measured on the equator in the direction of the signs of the zodiac (clockwise in our diagrams), starting from the vernal point, where the Sun passes from southern to northern declinations. They may be expressed either in degrees or in hours ($1^h = 15^\circ$). In the diagrams they are marked in degrees at the outer rim, together with the corresponding dates of the Gregorian calendar. In the course of $23^h 56^m$ the celestial vault makes one complete revolution (counter-clockwise in the diagram, clockwise in reality) about the pole.

summer solstice its AR is 90°, at autumn equinox it is 180°, and at winter solstice 270°.

Looking now at the constellations near the four cardinal points of the ecliptic, we see that Taurus, with the bright star Aldebaran, precedes the vernal point by *c.* 10–20°; equally Leo, with the "royal star" Regulus (Akkad. *šarru*), precedes the point of summer solstice by *c.* 15°, and Scorpius, with Antares, the autumnal point by the same amount. The region preceding the point of winter solstice is less rich in brilliant stars. It is occupied at a distance of *c.* 20° by our modern constellation Aquarius. At 270° we find the western, at 300° the eastern part of the Fishes (Pisces), linked together with a band, and between them the "Pegasus Rectangle". All three of them have a very long history, as will be shown in what follows. Of non-zodiacal constellations I mention first and foremost Cassiopeia (Sum. *lu-lim*, the Stag), found between the pole and the eastern Fish. Its original significance, Stag or Deer, is preserved in the Sphaera barbarica (e.g. in Abū Ma'shar), while in Greek astrothesy the constellation was renamed after the Ethiopian queen, Cassiopeia, the mother of the unfortunate Andromeda. As will be seen, the Stag played an important role in early calendariography.

II. 2. In diagram 2, the four ovals mark the four cardinal situations of the horizon of Persepolis with respect to the starred heavens:

(1) (right; unbroken line). The Sun stands at the vernal point, *c.* 20° below the horizon. As is seen, the Pleiades, forming the cusp of the Bull's western horn,[1] have their heliacal rising, i.e. reappear for the first time after a period of 40 days' invisibility; the "Horns of the Ibex" (anterior part of Aquarius)[2] culminate, and Scorpius, standing near the western horizon, has its cosmical setting. The situation is further clarified in diagram 3, which shows only the horizon at spring equinox.

(2) (lower; strokes and dots). The Sun stands at the point of summer solstice. Heliacal rising of the Royal Star, Regulus (α Leonis) and cosmical setting of the Horns of the Ibex.

(3) (left; long strokes). The Sun stands at the autumnal point. Heliacal rising of Scorpius, culmination of Leo, and cosmical setting of Taurus and Orion.

[1] Early astrothesy consistently represents the celestial bull's horns not straight, as assumed contrary to the rules of zoology by Ptolemy, but curved; cf. Hartner, "The Earliest History", pp. 7f.

[2] See below, fig. 10, p. 730.

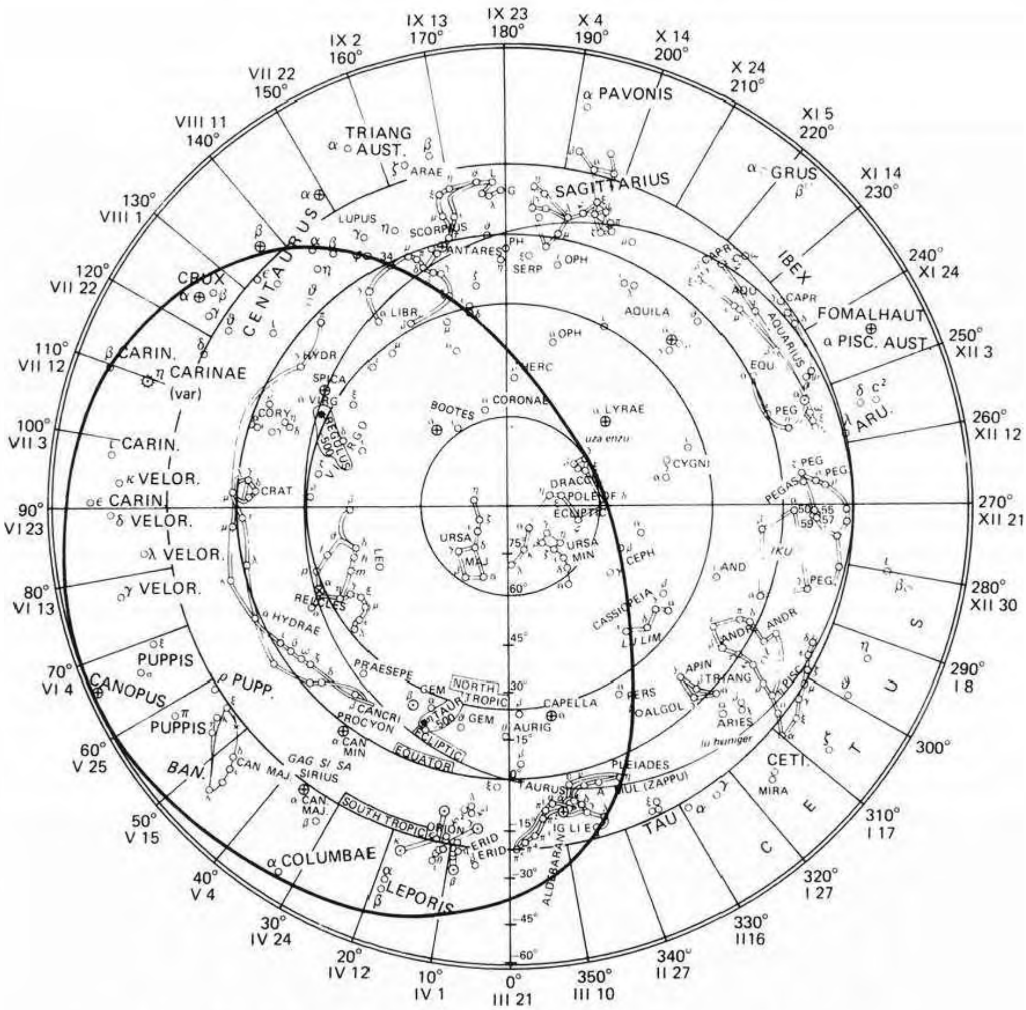


Diagram 2. The horizon of Persepolis, shewing the culmination of Leo.

(4) (upper; short strokes). The Sun stands at winter solstice. Heliacal rising of the first star of IKU, the Pegasus Square (β Pegasi); Sagittarius near culmination; cosmical setting of the hind-part of Leo.

In this list, only heliacal risings and culminations and cosmical settings are taken into consideration. It would be much longer and include other constellations, such as the Plough (APIN) and the Hired Labourer (LU.HUN.GA), the Twins (MAŠ.TAB.BA), the Snake-bearer (Ophiuchus) north of Scorpius and Sagittarius, etc., if we extended it to heliacal settings and acronychal risings and culminations.

Thus about 4000 B.C. the Sun's entering the four cardinal points of

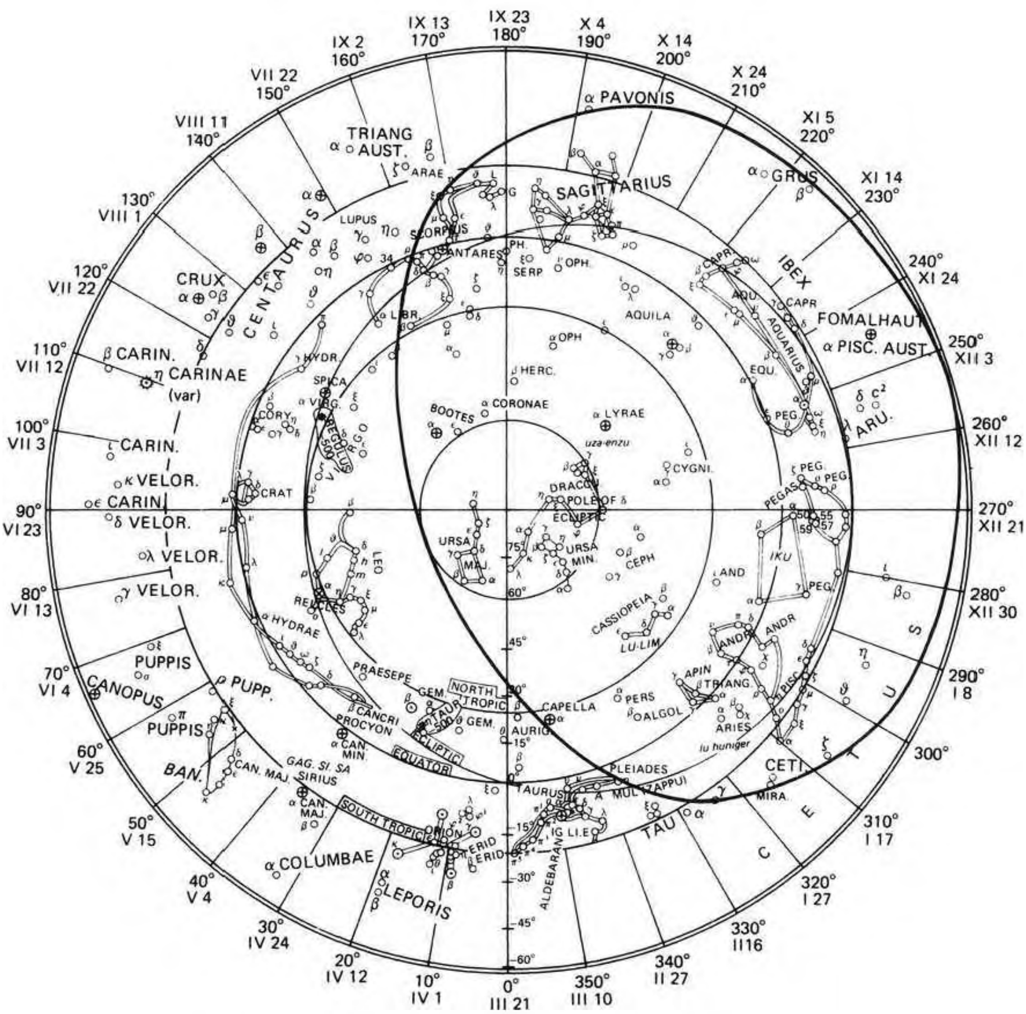


Diagram 3. The Persepolis horizon at the spring equinox.

the year coincided with the heliacal risings of the Pleiades and Taurus on 21 March, Leo (Regulus) on 23 June, Scorpius on 21 September, and the Pegasus Rectangle, IKU, on 21 December. Comparing these dates with the corresponding ones found in the ^{mul}APIN tablet (Pleiades on 20 April, Regulus on 24 July, Scorpius on 23 October, and IKU on 23 January), we find that they all lie *c.* one month earlier. Evidently, this is due to the effect of the precession of the equinoxes, which causes a change of roughly one month in 2,200 years.

II. 3. Now these theoretical considerations will be of interest only if the constellations mentioned can be proved to have been known to the

early settlers, in other words, if it is possible to establish an unbroken astrothetical tradition by which Iranian and Mesopotamian prehistory is linked together with the system characterizing the historical period. As it happens, hundreds of iconographies found on seals and vases from all over Iran and Mesopotamia demonstrate that such a continuity actually existed. Archaeologists seem so far to have overlooked their astronomical significance in spite of the fact that some typical features observable time and again should have excluded any attempt at a realistic, i.e., terrestrial, interpretation. Among these I mention the following:

a. The constantly recurring combination of two or more "calendrical" animals and symbols (stars, "IKU") in one and the same picture. Here I point out first and foremost the Lion-and-Bull Combat and its variant, the Lion-and-Deer Combat, which I have shown[1] to be interchangeable symbols denoting, in the fourth millennium, the beginning of agricultural activity after winter solstice, about 10 February: while Leo culminates at twilight (see diagram 2), the Bull (Taurus and Pleiades) and the Deer (*lu-lim*, Cassiopeia) simultaneously have their heliacal setting. Thereafter the Bull will remain invisible for a period of 40 days, after which its reappearance (heliacal rising) will mark the time of vernal equinox (see diagrams 2 and 3).

b. The fact that at least in some cases the animals in question are unambiguously represented as constellations (thus by marking stars on their bodies or stressing particular characteristics of the corresponding asterisms).

c. The manner of depicting in the same size animals that in reality differ enormously in size, such as scorpions compared with lions, bulls or ibexes.

d. Calendrical animals represented in characteristic attitudes deviating from the normal, above all upside-down, so as to symbolize their heliacal or cosmical settings, etc.

Some examples will serve to illustrate this.

[1] Hartner, "The Earliest History", pp. 15f.

Fig. 1. Prehistoric Elamite seal.[1] One of the earliest representations of the Lion–Bull combat; 4th millennium B.C. Note that only the Bull's forepart is represented.

Fig. 2. Prehistoric Elamite seal.[2] The celestial Lion with twenty-odd star dots on its body. In Ptolemy's star catalogue, 23 stars from the first to the fifth magnitude are listed, plus 4 of the sixth, which are at the limit of visibility. Approximately the same number of stars are represented on the Horoscope of Antiochus of Commagene (see next figure).

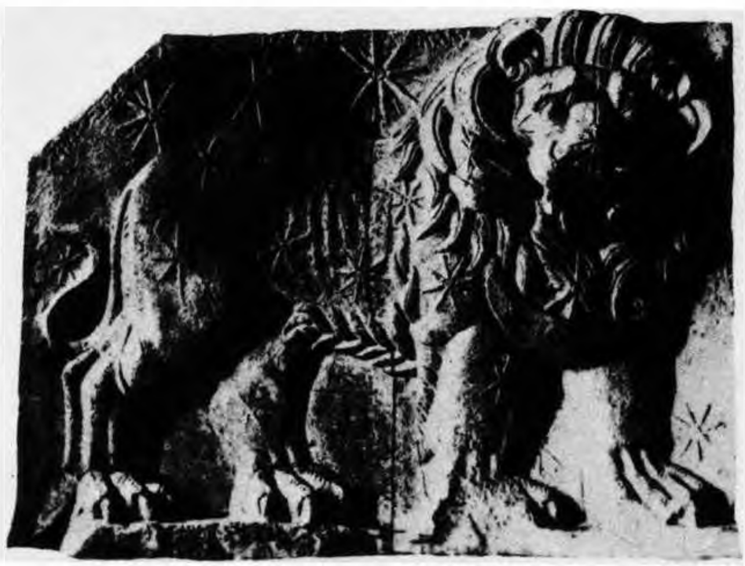


Fig. 3. Coronation horoscope of King Antiochus of Commagene, 62 B.C.[3] Note that the star symbol found on the shoulder of lions in Ancient Near and Middle Eastern (Sumerian, Babylonian, Ras Shamra) and Egyptian art down to the lions on Sasanian silver objects evidently indicates the "celestial" lion.

[1] M. Pézard, "Étude sur les intailles susiennes", *MDP* XII (1911), 98, fig. 70.

[2] M. Pézard, "Complément à l'étude sur les intailles susiennes", *MDP* XII, pl. IV, no. 172.

[3] K. Humann and O. Puchstein, *Denkmäler des Nemrud Dagh* (Berlin, 1890), pl. XXVI.

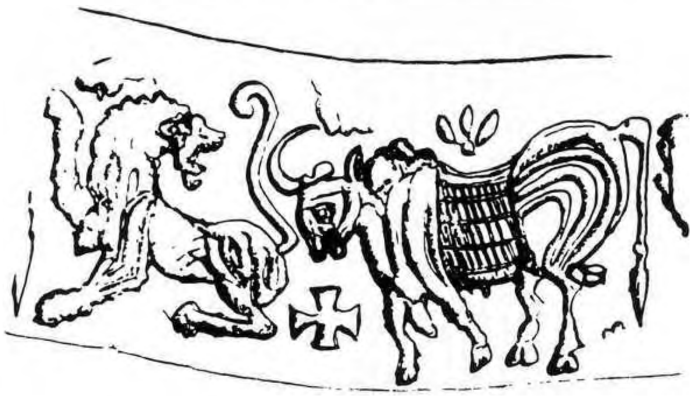
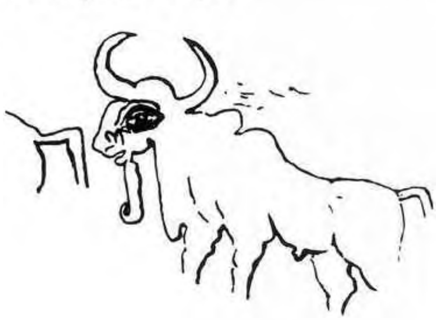
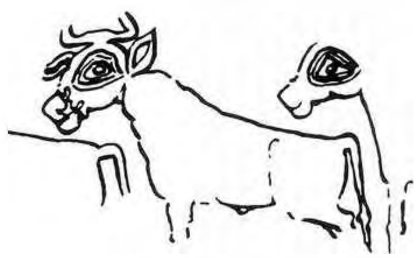


Fig. 4. Prehistoric Elamite seal.[1] Bull with body "cut off" by a saddle-like object. Of the celestial bull only the forepart is visible, whence it is often represented as either a bull's head or a protome (thus according to Ptolemy's catalogue). Cf. Fig. 1.





Figs 5 and 6. Prehistoric Elamite seals.[2] The Bull with a grotesquely exaggerated eye and (Fig. 5) a beard. The eye symbolizes the brilliant star Aldebaran. The terrestrial species bovidae is beardless; only the celestial Bull has a beard, formed by the stars λ, ϵ, τ, o, ξ, σ, ϕ Tauri.

[1] Fig. 5: L. Legrain, "Empreintes de cachets élamites", *MDP* XVI (1921), pl. X, no. 161; fig. 6: *ibidem*, pl. VI, no. 96.

[2] *Ibidem*, pl. VI, no. 98.

Fig. 7. Prehistoric vase from Tell Halaf.[1] The shoulder of the vase is decorated with bulls, th neck and the body with stylized bulls' heads against the starry heaven.

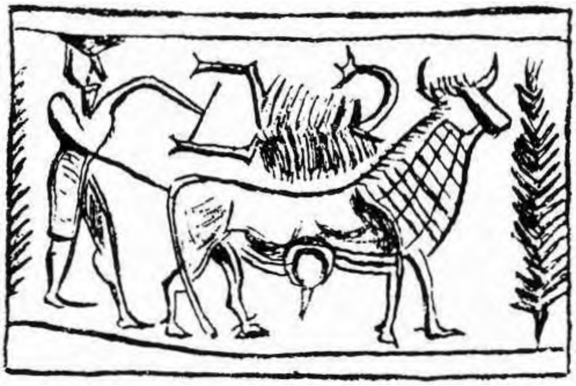


Fig. 8. Prehistoric Elamite seal.[2] Bull and Scorpion (the latter represented *c.* half the size of the former). The celestial cowherd is spurring the bull with a goad.

[1] Max Frh.v.Oppenheim, *Tell Halaf* I, *Die prähistorischen Funde*, ed. H. Schmidt (Berlin, 1943), frontispiece, fig. 2.

[2] M. Pézard, "Étude sur les intailles susiennes", *MDP* XII, p. 112, no. 107.

Fig. 9. Babylonian *kudurru*.[1] The Scorpion together with the Sun, the Moon, and Venus.

[1] *MDP* I (1900), pl. XIV.

Fig. 10. Prehistoric vases from Tepe Hiṣār.[1] The Ibex with a solar symbol in its horns, indicating the approaching time of winter solstice. The constellation of the Ibex, comprising at the earliest stage of civilization our constellations Capricorn (the later Babylonian "Goat-Fish", *suḫur-maš*) and Aquarius (Bab. GU-LA),[2] actually indicated by the heliacal rising of its horn the time immediately preceding winter solstice, while the very day of solstice, in theory, coincided with the heliacal rising of IKU and the western part of the Fishes. In practice, an exact determination of the day of solstice was impossible at that remote time. Therefore we are on safe ground if we assume that the Ibex and IKU together were considered the calendar asterisms foreboding the shortest days of the year. This explains why IKU, on a great many occasions (Susa, Persepolis), simply is substituted for the solar symbol in the horns of the constellation Ibex (see next two figures).

[1] E. F. Schmidt, "Tepe Hissar Excavations 1931", *The Museum Journal* XXIII (Philadelphia, 1933), pl. LXXXVII.

[2] See my reconstruction, Diagrams 1–4.

Figs 11 and 12. Prehistoric goblets from Susa I.[1] The Ibex with IKU in its horns. IKU, in Babylonian most frequently called 1-IKU, the "acre" or "unity of land", is the celestial "cultivated field" (our Pegasus Rectangle, see above, p. 724), represented as either circular (Susa) or lozenge-shaped (Persepolis, Tall-i-Bakun) and filled with various patterns (checker-board, stylized plants, etc.). Under the belly of one of the animals, the "sacred mountain" (cf. also fig. 10) symbolizing the Earth's eastern and western horizon, above which rise and below which set the celestial constellations.

[1] *MDP* XIII (1912), pl. IV, nos 1 & 2.

Fig. 13. Prehistoric vase from Tepe 'Alīābād.[1] Realistic representation of the heliacal rising of the Ibex: the celestial animal flanked by plants (the "sacred tree"); the rising Sun four times repeated.

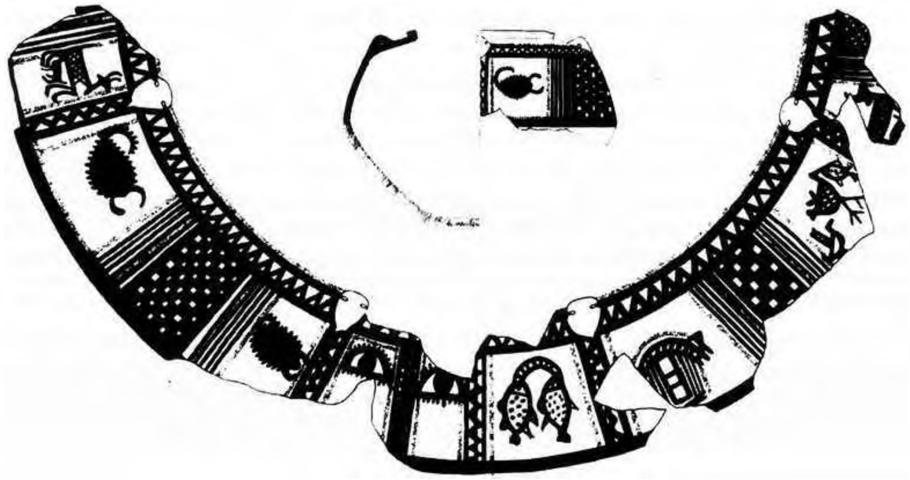


Fig. 14. Prehistoric vase from Jemdet Nasr.[2] From left to right the Goat (Sum. *uza*, α Lyrae) (?), the Scorpion, IKU, again the Scorpion, unidentifiable object (twice), the Fishes (Anunītu and ŠIM-MAḪ) linked together with a band (*rikis nūnu*),[3] the "Gates of the Heavens", often indicating, as the Sacred Mountain or Tree, heliacal risings or settings, etc.

[1] Gautier and Lampre, "Fouilles de Moussian", *MDP* VIII (1905), fig. 266, p. 136.

[2] Fig. 14: H. Field and R. A. Martin, "Painted Pottery from Jemdet Nasr", *AJA* XXXIX (1935), pl. XXXI; fig. 15: V. Christian, *Altertumskunde des Zweistromlandes* I, pl. 100, fig. 8.

[3] See P. Felix Gössmann, "Planetarium Babylonicum", in P. Anton Deimel (ed.), *Sumerisches Lexikon* IV. 2 (Rome, 1950), p. 35, no. 107: $^{\mathrm{mul}}$DUR nu-nu.

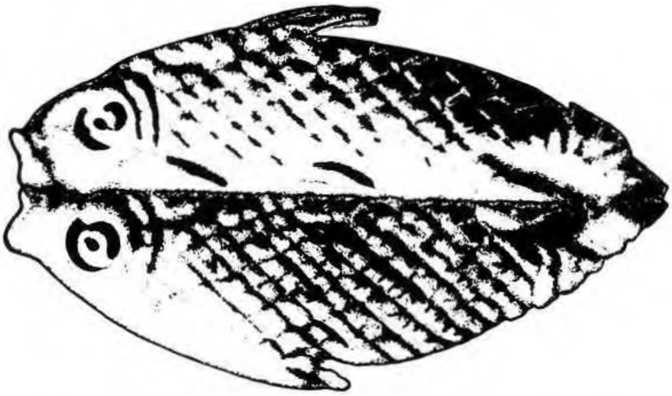


Fig. 15. Jemdet Nasr.[1] The Fishes linked with a band.

Fig. 16. Babylonian seal.[2] Lion over the Sacred Tree, Bull and Scorpion; above, Plough (APIN).

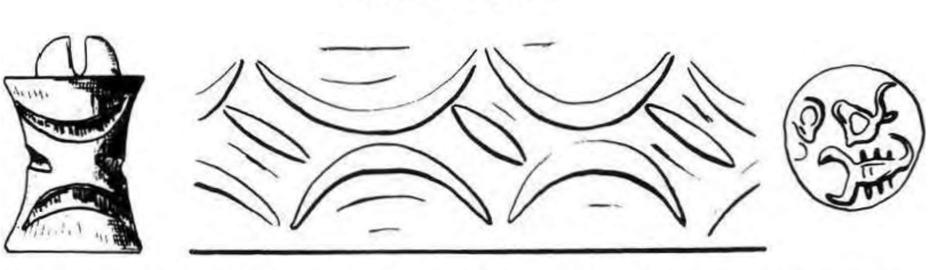


Fig. 17. Cylinder seal, late pre-dynastic period.[3] Lunar symbols (crescents). On bottom of cylinder, bull's head with a large eye and scorpion.

[1] Fig. 14: H. Field and R. A. Martin, "Painted Pottery from Jemdet Nasr", *AJA* XXXIX (1935), pl. XXXI; fig. 15: V. Christian, *Altertumskunde des Zweistromlandes* I, pl. 100, fig. 8.

[2] L. Legrain, "The Culture of the Babylonians from their Seals in the Collection of the Museum", University of Pennsylvania, The University Museum, *Publications of the Babylonian Section* XIV (Philadelphia, 1925), pl. IV, no. 51.

[3] P. Amiet, *La glyptique mésopotamienne archaïque* (Paris, 1961), pl. 51, no. 706.

Figs 18 and 19. Prehistoric seals from Tepe Giyan.[1] Two representations of the snake-bearing deity (note the star symbols), the prototype of the constellation Ophiuchus (Serpentarius).

[1] *Ibidem*, pl. 7, figs 149, 150.

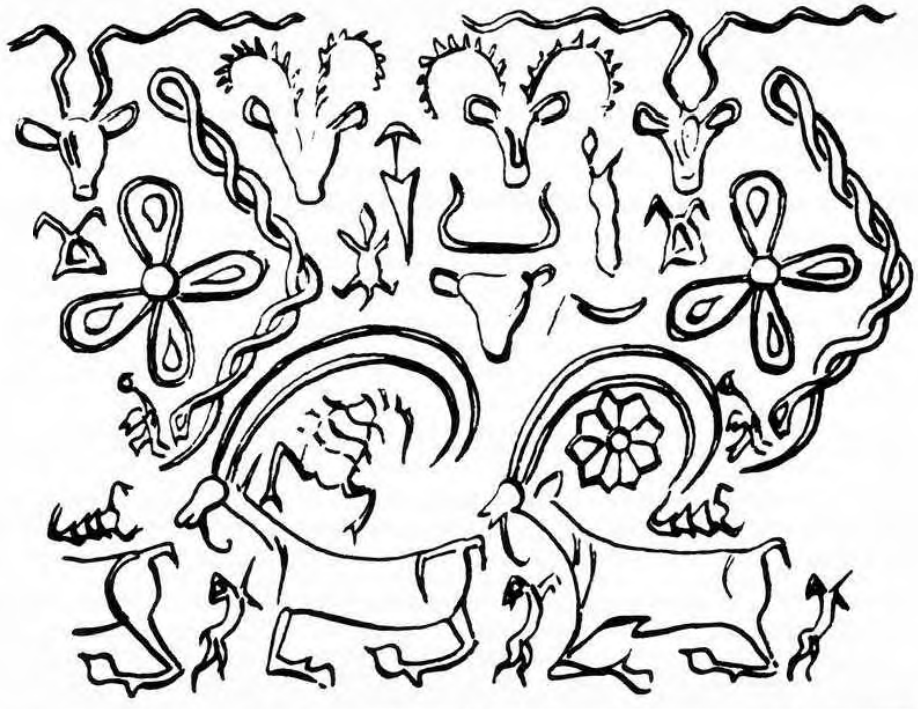


Fig. 20. Transition from pre-dynastic to archaic dynastic period. Two ibexes, one (left) with scorpion turned downwards in its horns, the other (right) with solar symbol in, and scorpion below, the horns (cf. next figure). Above, in centre, the bull's head, a snake and a four-petalled flower. On top, skulls of horned animals. Probable meaning: Taurus culminating, Hydra rising heliacally, Ibex setting cosmically, Scorpius in lower culmination. Solar date (3000 B.C.) end of July.[1]

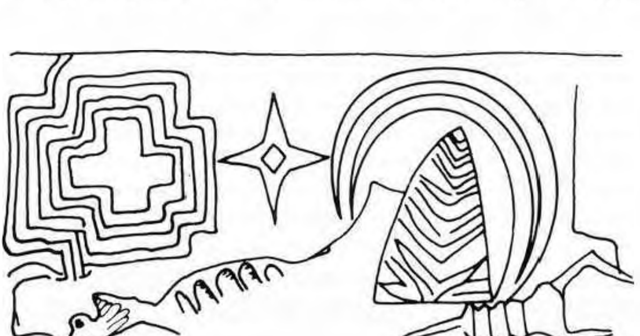


Fig. 21. Prehistoric. The horns of the setting Ibex encircle the sacred tree (or mountain). Under them, exactly as in the preceding figure, the Scorpion. At the centre, a four-pointed star (cf. the four-petalled flower in fig. 20) depicted in the same manner as Venus on the kudurrus (see fig. 9). To the left, a five-fold cross symbolizing probably IKU. Same solar date as fig. 20.[2]

[1] *Ibidem*, pl. 51, no. 707. [2] *MDP* XXIX (1943), p. 30, no. 1.

Fig. 22. Achaemenian wall sculpture at Persepolis, *c.* 500 B.C. One of the many colossal reliefs from the time of Darius the Great (519–486) and Xerxes (486–465) representing the Lion–Bull combat.

II. 4. While the astronomical significance of the animals and symbols occurring here is beyond dispute, it is not of course possible to establish a clear calendrical meaning in all the hundreds of examples encountered. Often it seems that no such was intended. Evidently there are many seals that originated from the artist's playing freely with the traditional symbols, and others in which the symbols were used only as owner's marks or for other unknown purposes. But in a great many cases the artist's intention to represent symbolically a well-defined solar date is unmistakable. Among these, contrary to what one might expect, the equinoxes and solstices play a not necessarily predominant role. A primitive calendar serves other than purely astronomical purposes. It will insist above all on dates that are of interest to agriculture; thus Hesiod, to give one example out of many, makes reference only to the times for ploughing and harvesting but not to the four cardinal points of the solar year.

Now the same constellation whose heliacal rising and cosmical setting are mentioned in Hesiod: the Pleiades[1] – together with the Bull,

[1] See p. 718.

with which they form an inseparable unity[1] – was considered of paramount importance by the early settlers in Elam and Mesopotamia, witness the numberless bulls and bull's heads on seals and vases, a small selection of which is given in our illustrations.

THE LION–BULL COMBAT

II. 5. Of all combinations in which this celestial bull is found, the one with the lion – the "Lion–Bull combat" – is undoubtedly the most characteristic and at the same time the most persistent, having a tradition stretching over at least five millennia.[2] On the basis of the preceding demonstrations, its original meaning becomes obvious (see diagram 2). When, about 10 February, by the beginning of the fourth millennium, the Bull with the Pleiades started setting heliacally, the Lion with the brilliant star Regulus, below it the brightest star, α, of the constellation Hydra and, close to the horizon (perhaps not yet recognizable), Canopus (α Argus) were simultaneously culminating. One hardly needs to justify the expectation that this striking moment, being the celestial signal for starting agricultural activity at the end of the cold season, would have been paid due attention and would have found expression in pictorial representations of various kinds: the triumphant Lion, standing at zenith and displaying thereby its maximum power, attacks and kills the Bull trying to escape below the horizon, which during the subsequent days disappears in the sun's rays to remain invisible for a period of 40 days. Then it is reborn, rising again for the first time, on 21 March, to announce spring equinox and the advent of the light part of the year.

In the course of time, owing to precession, the date defined by the "Lion–Bull combat" gradually changed. About 3000 B.C. (early Sumerian time) it fell on *c.* 25 February, about 2000 B.C., on 10 March, about 1000 B.C., on 22 March; finally, about 500 B.C. (time of Darius the Great), on 28 March, or *c.* one week after spring equinox. This situation is demonstrated in diagram 4, where the Sun is marked standing 20° below the western horizon of Persepolis (oval curve), the position of the Pleiades (η Tauri) and of Regulus for 500 B.C. being indicated by encircled asterisks with the corresponding star names.

[1] See p. 722.

[2] See W. Hartner and R. Ettinghausen, "The Conquering Lion. The Life Cycle of a Symbol", *Oriens* XVII (1964), pp. 161–71.

Considering the fact that the determination of the equinoxes as well as the observation of the disappearance of the Pleiades may be wrong by several days, we thus find that the Lion–Bull combat, during the first half of the first millennium B.C., lent itself as a most convenient and natural symbol to denote spring equinox. There can be no doubt that it was for this and no other reason that Darius deemed it worthy of serving as favourite ornamental motif on the eastern flight of stairs of the *apadāna* at Persepolis. As will be seen, the symbol bears directly on the question of the introduction of the Later Avestan calendar.

THE LUNISOLAR YEAR

II. 6. While all the demonstrations given so far refer exclusively to the Sun's yearly course through the constellations near the ecliptic, nothing has yet been said about the Moon's role except for my initial generalizing remark that it must needs have always been regarded as the chief time indicator. This means that its phases originally served to measure – not to count – short periods of time, roughly 7–8 days for each of the four main phases, and 29 or 30 for the lunation. The need of adapting the lunar time-reckoning to the solar could be felt only after the solar year had been recognized as the "skeleton" of time count. The space between two consecutive annual solar phenomena, such as the heliacal rising of a certain asterism, was found to be filled by more than 12 and less than 13 lunations, which in due time gave rise to the idea of making normal years of 12 months alternate with long (intercalary) years of 13. The rule for intercalation was a matter of course. Since 12 months comprise 354–355 days, the beginning of the lunar year will recede from a given solar date by 10 days each year, whence a 13th month will have to be intercalated at the latest after the 3rd year. This empirical method, which requires a constant surveying of the celestial phenomena, will in practice occasion many erroneous intercalations. It was later replaced by cyclical intercalations based on the exact knowledge of the periods concerned. From the approximate equation: 8 years = 99 months, it resulted that 3 months had to be intercalated in the course of 8 years (*octaëteris*, $8 \times 12 + 3 = 99$); from the better approximation: 19 years = 235 months, resulted the intercalation of 7 months in 19 years ("*Metonic*" *cycle*, $19 \times 12 + 7 = 235$); see III 3–4 (pp. 742–3).

From the cuneiform texts it becomes evident that, still in 541 B.C., a second Addaru was ordered by royal decree to be intercalated. The

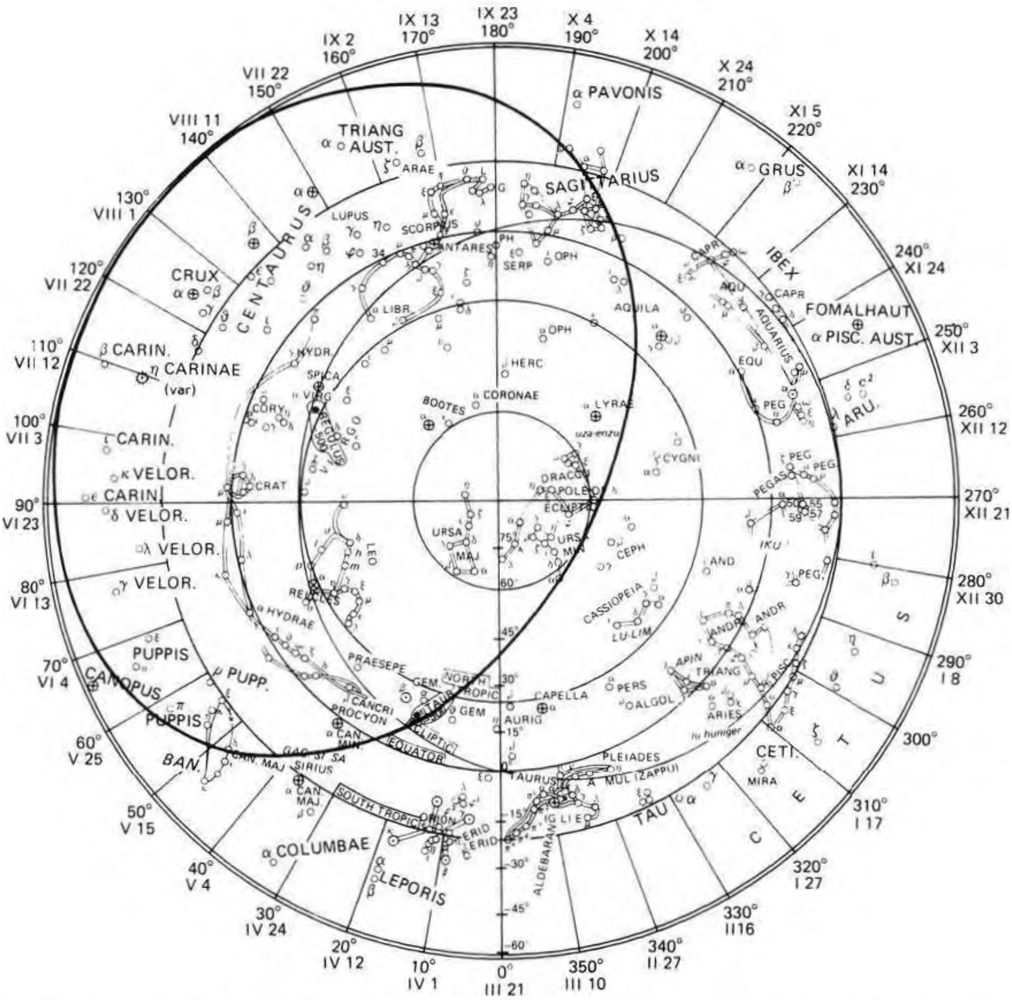


Diagram 4. The Persepolis horizon one week after the spring equinox, at the time of Darius.

cyclical intercalations, which appear for the first time in 527, will be discussed in Part III. The fact that the first introduction of a calendar based on a scientific method took place during the time immediately following the Persian conquest of Babylon (539 B.C.), as will be seen, is hardly accidental.

PART III. THE BABYLONIAN AND THE OLD IRANIAN CALENDARS

III. 1. In late Babylonian times the first month of the lunisolar year, Nīsannu, was the one whose neomenia occurred about the time of spring

equinox.[1] In all probability this had been the rule long before.[2] How, and how accurately, the equinox was observed during the earliest period cannot be ascertained. At the latest in the last decade of the 6th century, as results from the arrangement of the lunisolar calendar, it was determined with remarkable accuracy. For its approximate determination, however, already at Ammiṣaduqa's time (early 16th century B.C.), the Lion–Bull combat situation, i.e. the heliacal setting of the Pleiades, situated in the western horn of Taurus, occurring then about 15 March (Gregorian) = 28 March (Julian), could have served, and probably did serve, as a convenient means. It seems indeed plausible that the lunisolar year ended with the last visibility of Taurus, considering the Moon's age-old association with the Bull (witness the numberless prehistoric seals representing both in significant combination, see fig. 17 *et passim*), which is reflected still in the hellenistic (Seleucid and Greek) system of astrological exaltations (ὑψώματα).[3]

A thousand years later, in Babylon and in Persepolis alike, the heliacal setting of the Pleiades took place about 28 March (Gregorian) = *c.* 2 April (Julian); this means that it fell by the same length of time later than the equinox (21/26 March), as the length of time by which it had preceded it a millennium earlier. During this long period the heliacal setting of Taurus-Pleiades could thus serve to announce the end of the old and the beginning of the new lunisolar year. It will be shown, however, that already before the end of the 6th century a system based on the "phases" (annual risings and settings) of certain prominent stars or constellations (among which also the Pleiades) was in use to determine with remarkable accuracy the two solstices and spring equinox as well as four more solar dates (see III 14–19, pp. 750–756).

[1] For the following I refer to R. A. Parker and W. A. Dubberstein, "Babylonian Chronology 626 B.C.–A.D. 75", *Brown University Studies* XIX (Providence, 1956).

[2] Other competitive systems, with the year beginning at Autumn equinox or Summer solstice, may have existed at different times and places (in the Sumerian city communities, early Assur, etc.).

[3] See W. Hartner, "The Pseudoplanetary Nodes of the Moon's Orbit in Hindu and Islamic Iconographies", *Ars Islamica* V (Ann Arbor, 1938), pp. 113–54 (reprinted in W. Hartner, *Oriens–Occidens* (Hildesheim, 1968), pp. 349–404). From the same remote antiquity stems of course the Lion's association with the Sun in the astrological system of the *domicilia*.

THE BABYLONIAN CALENDAR

III. 2. The names of the Babylonian months, essentially the same as the Aramaic ones known from the Jewish calendar, are:

1. Nīsannu (beginning about vernal equinox)
2. Aii̯āru
3. Sīmannu
4. Du'ūzu (beginning about summer solstice)
5. Ābu
6. Ulūlu
7. Tašrītu (beginning about autumn equinox)
8. Araḫsamna
9. Kisilīmu
10. Ṭebētu (beginning about winter solstice)
11. Šabāṭu
12. Addāru

As in most other lunisolar calendars (except for the Chinese, which is based on the true conjunctions), the first day of the month is the one on which the thin crescent of the New Moon for the first time after conjunction becomes visible after sunset, whence, logically, the days are counted from sunset. Intercalary months are inserted either at the end of the year, after the month Addāru (cf. the Jewish Adar-šenī or Ve-Adar), or after the 6th month, Ulūlu. Theoretically a second Addāru would thus have to be intercalated when the neomenia of the regular Addāru has receded more than a month from spring equinox, while the intercalation of a second Ulūlu would analogously have to be regulated by autumn equinox, which in the 6th century, when it fell on 26 September (Julian), coincided very closely with the heliacal rising of the brilliant star Spica (α Virginis)[1] and with the heliacal setting of α Librae. By contrast, A. Sachs[2] finds that intercalations were regulated in Seleucid times by the heliacal rising of Sirius, which should always fall in the 4th month, Du'ūzu. On checking with Parker–Dubberstein's tables one notices that this latter rule seems applicable even to most intercalations of the preceding two centuries, from the time of Cambyses (529 B.C.) onwards, though exceptions can be found in quite a few cases. For the pre-Seleucid period as a whole the number of such exceptions

[1] Bab. ^{mul}*ab.sin* = "corn ear" (Spica). The name has survived in the star name ἄψινθος (*Rev.* 8.11), which would otherwise be inexplicable. Note that the heliacal rising of Spica on 26 September (Jul.) = 20 September (Greg.) is referred to an ideal level horizon. For the mountainous horizon of Persepolis it fell *c.* 12 days later (see III. 16f., p. 753).

[2] "Sirius Dates in Babylonian Astronomical Texts of the Seleucid Period", *JCS* VI (1952), 105–14; cited after Parker–Dubberstein, p. 3, n. 4.

is considerably reduced by assuming as valid the "theoretical" rule postulated above, that the first month is to start about or after spring equinox and that autumn equinox must fall in the sixth, Ulūlu. In particular, all the second Ulūlus recorded from the time of Nebuchadnezzar II (604 B.C.) onwards appear consistently intercalated according to this rule, while not all of them follow from the "Sirius-Du'ūzu" rule. After the introduction of the 19-years' ("Metonic") cycle, of which I shall speak presently, the two rules can be fused into one, in other words, starting with the 19th year of the reign of Darius (503 B.C.) the earliest solar date for the beginning of the year becomes spring equinox (25, 26 or 27 March Julian).[1] Depending on meteorological conditions, the heliacal rising of Sirius then falls on one of the last days of Du'ūzu or on the first of Ābu, and autumn equinox is not reached in the course of Ulūlu, whence either of the two phenomena may serve equally well to indicate that a second Ulūlu is to be intercalated.

III. 3. While in the earliest period intercalations were decreed according to the merit of the case, the first regularity becomes manifest during the reign of Cambyses (529–22 B.C.). In his third year, i.e. starting on 21 March 527, a second Ulūlu (15 September) is inserted and thereafter the 5th and 8th years of his reign have an intercalary Addāru each (19 March 524 and 15 March 522). Three years after, in the 3rd year of Darius, starting on 23 March 519, a similar cycle begins with a second Ulūlu in the first year (17 September) and then follow second Addārus in the 5th and 8th years (20 March 516 and 17 March 513) respectively. Again, a new cycle begins in the 11th year of Darius, starting on 25 March 511, with an intercalary Ulūlu (18 September), after which follow second Addārus in the 13th and 16th years (21 March 508 and 18 March 505).

This is the first indubitable occurrence of the octaëteris mentioned at the end of Part II. It is based on the equations

$$a = 99 \text{ lunations of } 29.53059 \text{ days} = 2923.52841 \text{ days}$$

and

$$b = 8 \text{ Julian years of } 365.25 \text{ days} = 2922.00 \text{ days}$$

$$(\text{Difference, } a - b = 1.53 \text{ days}),$$

from which it results that the beginnings of corresponding months will after each octaëteris fall on a Julian date that is *c.* 2 (theoretically 1.53) days later than the preceding. Thus in 527 the beginning of the year

[1] With the sole exception of 500 B.C., when the year began on 23 March.

falls on 21 March; in 519, on 23 March; in 511, on 25 March, while the dates for the second Ulūlus are 15, 17 and 18 September respectively.

III. 4. In the 19th year of Darius, 503 B.C., the beginning of the year (1st Nīsannu) had advanced to 27 March, i.e. the very day of spring equinox, and the second Ulūlu started on 20 September. Now this year marks the end of the octaëteris count and the beginning of the 19-year cycle, which we are used to call by the Greek astronomer Meton's name because it was he who 70 years later, about 430 B.C., introduced it in the Athenian calendar. This cycle is founded on the equations

$$\mathrm{c} = 235 \text{ lunations} = 6939.68865 \text{ days}$$

and

$$\mathrm{d} = 19 \text{ Julian years} = 6939.75 \text{ days}$$

$$(\text{Difference, } \mathrm{c}-\mathrm{d} = -0.06 \text{ days} = c.\ -1\tfrac{1}{2} \text{ hours}).$$

Evidently it warrants a much higher degree of accuracy. The error one commits by using this cycle amounts to one day in *c.* 300 years. Consequently, with the beginning of each new cycle the beginning of the lunisolar year will over a very long period of time recur to the approximate date of spring equinox, which fell on 27 March in the 6th century B.C., and on 23 March in the 1st century A.D.

Here one might object to my assumption that the first year of each octaëteris as well as of each Metonic cycle was the one in which a second Ulūlu had to be intercalated, while there seems to be tacit agreement among earlier authors that a cycle has to end, not to begin, with an intercalary year. A theoretical rule cannot of course be established. But evidently only the beginning of a cycle on the lowest possible solar date, which is at the same time a day close to spring equinox, does make astronomical sense, while any other beginning for the first of the three consecutive octaëterides, such as 12 April 529 or 1 April 528, would seem arbitrarily chosen.

III. 5. There can be no doubt that the date of the equinox, 27 March 503 B.C., was selected intentionally to commence a new and better calendrical system. From the sequence of intercalations in the first 19-year cycle, however, it can be seen that the calendar makers had not yet understood thoroughly how the effect intended could be warranted; for instead of intercalating a second Addāru in the 3rd year of the cycle, they postponed it to the end of the 4th year, whereby they allowed the 4th year to begin on a date preceding the equinox by *c.* 4 days: 23 March 500 B.C. As for the rest of the intercalated second Addārus, they prove

to be in accordance with the ideal scheme underlying all later cycles. Starting with the second year of Xerxes, 484, the first year of the next as well as of all later cycles has an intercalary Ulūlu; then follow intercalary Addārus at the end of the 3rd, 6th, 9th, 11th, 14th and 17th years.

III. 6. A few exceptions to the rule seem of interest.

On the one hand, for the two intercalations of a second Ulūlu due in the 19th and 38th years of the reign of Artaxerxes I (446 and 427 B.C.) a second Addāru is substituted, while for the rest the established scheme is not altered. Thereby, starting with the second year of Artaxerxes, a sequence of 20 second Addārus is obtained all of which start on days comprised between 15 and 25 March, in other words, shortly before the equinox. Only in the 16th year of Darius II (408 B.C.) does the calendar resume its former shape by the intercalation of a second Ulūlu. This aversion to intercalating a month in the middle of the year seems only explicable in terms of a wish conceived for unknown reasons, to regulate the calendar exclusively by the equinox.

On the other hand, the cycle starting in the 16th year of Artaxerxes II, on 26 March 389, has an intercalated second Addāru at the end of the 5th instead of the 6th year. This causes the 6th year (384) to start one month too late, on 29 April, whereby, for the first and only time since the 12th and 15th years of Nebuchadnezzar I (starting 30 April 593 and 27 April 590 respectively), the accepted rule is violated. No plausible reason for this anticipated intercalation can be adduced. It seems to have been a mere slip.[1]

THE OLD PERSIAN LUNISOLAR CALENDAR

III. 7. In the trilingual Behistun inscription, written in cuneiform Old Persian, Elamite and Akkadian, Darius states twice that the defeat and

[1] This one slip, the only one in more than a century, induces Parker–Dubberstein to claim that the 19-year cycle came into being only after 367 B.C. or "possibly as early as 383 B.C.". Similarly O. Neugebauer, *The Exact Sciences in Antiquity*, 2nd ed. (Providence, R. I., 1957), p. 140, judges that "the 19-year cycle was introduced into consistent calendaric use very close to 380 B.C. This gives Meton a priority of about 50 years and opens the possibility of an originally Greek discovery." By contrast van der Waerden, reviewing Parker–Dubberstein in *Bibliotheca Orientalis* xv (1958), p. 107, arrives at the same conclusion as to the introduction of the *octaëteris* and of the 19-year cycle as I do above, though without recognizing the decisive fact that the years having a second Ulūlu consistently begin very precisely at spring equinox. The second Addārus substituted in March 446/45 and 427/26 for second Ulūlus are not of course exceptions to the 19-year cycle, as one might interpret (erroneously) van der Waerden's words. In point of fact they do not affect the cycle at all; neither does the anticipated intercalation of 385–384 (see above).

capital punishment, after the assassination of the false Smerdis, of eight more usurpers took place *hamahyāyā θarda*, "in one and the same year" (DB §§52 and 56). In the preceding paragraphs the dates of eighteen battles, fought in nine different months, are given according to the Old Persian calendar, but unfortunately not in a chronological sequence. Many attempts had been made to equate the names of these nine months[1] with those of the Babylonian calendar (Rawlinson, Oppert, Unger, Justi, Prašek, Marquart) until, thanks to the discovery of new tablets written in Akkadian and Elamite, which contain also the names of the missing three months, Arno Poebel[2] succeeded in setting up equations that will have to be regarded as definitive. They prove on the one hand that all previous identifications were erroneous, on the other that Darius' bold claim to have defeated his enemies in the course of one year is only slightly exaggerated: in truth it took him 13 months plus 12 days to reduce his countries with savage cruelty to peaceful conditions.

III. 8. In addition to the Old Persian month names in Old Persian script and in Elamite script, a different, genuine Elamite set of names is found in the tablets. In the following list, given after Hallock,[3] the rendering in Elamite script of the Old Persian names followed by the Old Persian Behistun names (in brackets) is given under *A*, while the corresponding proper Elamite names are listed under *B*, and the Babylonian month names under *C*.

Hallock, in his ensuing analysis of attested intercalations, takes it for granted that in the Old Persian variety of the lunisolar calendar the same rules prevailed as in the contemporary Babylonian. This, however, should not *a priori* be considered a matter of course. As will be seen

[1] One of them is preserved only in the Elamite form: Markašanas. It corresponds with the Akkadian month name Araḫsamnu = Aram. Marḥešwān and is doubtless borrowed from the Semitic name. R. T. Hallock, in *PFT*, 74, n. 11, does not deny the possibility of a borrowing (*via* Old Persian) but holds against it that no other Old Persian month name has a Semitic derivation. This argument is invalidated by the fact that even in our days there are languages (Polish, Czech, Basque) that have indigenous names for the months except for one or two (thus Polish *marzec* and *maj*) which are borrowed from the Latin names, or one may rather say, where the Latin names have not been supplanted by indigenous ones; thus Basque gives preference to Apirilla and Maiatza over the genuine Basque Jorailla and Orrilla.

[2] See his articles in *AJSLL* LV (1938), 130–65 (esp. 139–42), 285–314, LVI (1939), 121–45; cited after R. G. Kent, *Old Persian*, p. 160, n. 1. The material on which Poebel based his reconstruction of the Old Persian calendar was subsequently made available in two monumental publications: G. G. Cameron's *PTT*, and R. T. Hallock's *PFT*.

[3] *PFT*, p. 74.

	A	*B*	*C*
I	Hadukannaš (Adukanaiša)	Zikli	Nīsannu
II	Turmar (Θūravāhara)	Zarpakim	Aịịāru
III	Sākurriziš (Θāigraciš)	Hadar	Sīmannu
IV	Karmabataš (Garmapada)	Hallime	Du'ūzu
V	Turnabaziš	Zillatam	Ābu
VI	Karbašiyaš	Belilit	Ulūlu
VII	Bakeyatiš (Bāgayādiš)	Manšarki[1]	Tašrītu
VIII	Markašanaš	Lankelli	Araḫsamna
IX	Hašiyatiš (Āṣiyādiya)	Šibari	Kisilīmu
X	Hanamakaš (Anāmaka)	Šermi	Ṭebētu
XI	Samiyamaš	Kutmama	Šabāṭu
XII	Miyakannaš (Viyaxana)	Aššetukpi	Addāru

he thereby encounters difficulties that can be avoided if the assumption of a perfect parallelism is dropped.

III. 9. Intercalations are indicated by the term *beptika* (rendered tentatively by Hallock as "shifted"), standing after the name of the month. It occurs three times, on three different tablets, all from the 22nd year of Darius (500–499 B.C.) in combination with the Elamite name of the 12th month: Aššetukpi beptika. Since in the Babylonian calendar this year has an intercalary second Addāru (starting on 12 March), beptika evidently means nothing but "intercalary".

Now the same term beptika is found also attached to Old Persian month names: three times, all in the 19th year (503–502), to the 10th month, Hanamakaš (= Ṭebētu), and once in the 23rd year (499–498), to the first, Hadukannaš (= Nīsannu). Comparing this with the Babylonian calendar, to which an intercalary Ṭebētu is alien, we find that the 19th year has a second Ulūlu, starting on 20 September, and that the 23rd year begins with the month Nīsannu = Hadukannaš on 11 April 499, which follows immediately after the second Addāru (beginning on 12 March 499) at the end of the preceding 22nd year. From this Hallock concludes that in combination with Old Persian names beptika does not mean "intercalary", but serves only to indicate that an intercalation had taken place one (thus in the 23rd year) or several (thus in the 19th year) months before.

[1] In six of the Fortification texts and in the economic texts from Susa (e.g. *MDP* IX (1907), no. 27) the month name Raḫal occurs; according to Hallock, *PFT* 75 and 747, col. 1, it is the Susan name for the seventh month, Manšarki.

III. 10. It goes without saying that this is utterly improbable. A more reasonable explanation of the baffling discrepancy will emerge if one takes it for granted that the crucial word, beptika, always meant "intercalary": the Old Persian and the Babylonian calendars will then have had different systems of intercalation. The latter we have seen operated with irregular, empirical Ulūlu and Addāru intercalations down to 527, then passed over to the octaëteris and finally, when in the 19th year of Darius the beginning of the year coincided with spring equinox, to the 19-year cycle. We have seen moreover that in the Babylonian calendar the Addāru intercalation due in the 21st year of Darius (501–500) was not carried out before the year after, which caused the 22nd year (500–499) to start on a day *preceding* the equinox. The transition period, comprising the first year of the 19-year count is thus characterized by uncertainty and experimentation; it comes to an end only with the correct Addāru intercalation of the 24th year (498–497).

III. 11. It is just during this transition period that similar discrepancies become manifest in the Old Persian calendar. About its earlier history nothing definite is known, but there can be no doubt that it was lunisolar, as was the neighbouring Babylonian, and that intercalations must have been made on an empirical basis. And it is of empirical intercalations that we find significant traces in the four tablets under discussion (PFT 1069, 1070, 1073 and 1053).

The former three we have seen mention an intercalary 10th month, Hanamakaš (= Ṭebētu) beptika, in the 19th year (503–502). This can be explained by the supposition, for which further evidence will be adduced,[1] that the second chief solar term regulating the Old Persian year, next after spring equinox, was not autumn equinox but winter solstice (determined, as will be shown in what follows (see Tables 2 and 3) by a multitude of prominent star-phases), so that the 10th month would have to start about or after the solstice. Now in the 19th year of Darius, beginning on 27 March 503 B.C., the neomenia of the 10th month fell on 17 December, 11 days before the solstice; an intercalation therefore became necessary.

According to the practice of the Babylonian calendar, the 10th month of the year would then have been decreed to be an intercalary 9th month (IXa, i.e. a second Kisilīmu) and the following month, starting on 15 January 502, the regular 10th month, Ṭebētu. But the texts mention an intercalary (beptika) Hanamakaš = Ṭebētu. This discrepancy (if I am

[1] See III. 13ff.

right in surmising that the winter solstice played a predominant role in the Old Persian calendar) disappears if we assume that beptika in combination with Old Persian month names indicates the month *preceding* the regular month, and not, as in the case of Elamite (and of course also of Babylonian) month names, the one following it (see Table 1).

The last tablet (PFT 1053), which mentions a Hadukannaš (= Nīsannu) beptika in the 23rd year, seems to bear out my theory. We have seen that the Babylonian Addāru intercalation due in the year 21, owing to the ruling confusion, was postponed to the end of year 22, to the effect that Addāru II began on 12 March 499, and the month Nīsannu of year 23, on 11 April. The Elamite months, as attested by the three tablets mentioned, were already brought into accord with the Babylonian, whence the tablets record an Aššetukpi beptika corresponding to the Addāru II of the Babylonian calendar. As for the Old Persian calendar, which in accordance with year 19 should have inserted an intercalary 10th month on 14 December 500, it became finally adapted to the Babylonian by the intercalation of a Hadukannaš beptika of year 23. For if, as here suggested, beptika indicates the intercalary month preceding the regular one, Hadukannaš beptika of year 23 becomes identical with Addāru II of year 22. I am aware of the difficulty of accepting that the position of the beptika month should have been different in Elamite and Old Persian usage;[1] but no other reasonable possibility of explaining the apparent contradictions found in the surviving texts offers itself, and there is little hope of discovery of new inscriptions that would permit testing the theory here offered.[2]

[1] [The difficulty should not be allowed to prevail over the great merit of the proposed solution. If the Persians named the intercalary month after the nearest regular month ahead, the Elamites after the nearest behind, the difference was not calendrical but merely terminological. Since the El. verb *bepti-* meant "to rebel", it may help to recall that in Middle Persian, quite likely in continuation of Old Persian usage, intercalary days were referred to as "stolen" (*truftag*, *duẓīdag*, cf. H. S. Nyberg, *JA* 1929, p. 293; see also below, pp. 758 and 760–1). The two meanings have in common the connotation of "improper claim", we might say "pretension". To the Elamites, then, an intercalary IXa or XIIa would be "the pretended, *soi-disant* IX or XII", to the Persians "the pretended X or I". This would be no more than in harmony with the forward orientation of the "Zoroastrian" names of the second and third "Creator" days in Pahlavī, whose need to be distinguished from the first "Creator" day is met by referring either to the day immediately following, and not to the immediately preceding (see below, p. 776). *Dai pad Ādur* means "Creator(-day) at Fire(-day)", with "at" used in the sense of "by, adjacent to, French *chez*". The Sogdian name *Āš Δəšči* of the same day, the 8th of the month, means genitivally "Fire(-day)'s Creator(-day)". One may also compare the wholly explicit Elamographically written Old Persian phrase "by a quarter short of a shekel", meaning "three quarters of a shekel" and reflecting the forward outlook in reckoning familiar from Latin *duodeviginti*; see *TPS* 1969, 166f. Ed.]

[2] As a much less reasonable alternative I mention the following: the beptika month, also in

III. 12. As the Persepolis Treasury Tablets[1] show, the Old Persian lunisolar calendar remained in use until at least 459 B.C. Although at the latest about the middle of the 5th century the Later Avestan calendar became firmly established among the Zoroastrians of Iran, the Old Persian calendar may have continued as the official civil calendar throughout the Achaemenian period. This is Taqizadeh's conjecture, in one of his important papers on the subject.[2] He founded it on the fact that Herodotus (III.79) and after him, about 400 B.C., Ctesias, mention the feast of the Magophonia (*μαγοφόνια*) celebrated each year in commemoration of the elimination of the Magian usurper Gaumata who, according to the Behistun inscription, was killed by Darius on the 10th day of the 7th month (Bāgayādiš) of the Old Persian year. Taqizadeh, however, seemed to believe that this date: 7th month, 10th day, is actually found also in Ctesias, but this is a mistake. Nothing but the fact that the Magophonia were celebrated every year is recorded by the two authors.

THE OLD AVESTAN YEAR. THE SIX GĀHĀNBĀRS

III. 13. The theory of the independent existence of an Old Avestan religious calendar in use with the pre-Achaemenian and Achaemenian Zoroastrian communities, probably already before Zoroaster's own time,[3] is supported by two arguments: (1) the inclusion in the Later

Old Persian, always *follows* the regular one; then, in year 19 (see Table 1) the regular 10th month begins on 17 December 503 and the next one (15 January 502) is decreed intercalary though with no plausible astronomical motivation. Now, introducing for brevity's sake the term "Elamite year" as against "Old Persian year", we have at the end of year 22 the Elamite Aššetukpi beptika in the same position as the Babylonian Addāru II, while the Old Persian year 22 ends with the regular 12th month. Thereafter, the first month of Old Persian year 23 coincides with the Elamite Aššetukpi beptika of the preceding year, and the OP Hadukannaš beptika (= Nīsannu II), with the regular Elamite first month of year 23. This would imply a discrepancy of one month between the two year forms, and not before the second month (beginning 10 May) would the concordance be restored. Since the tablets in question concern allotments to be made to workmen, it is very improbable that a centralized administration such as the Achaemenian could afford this kind of uncertainty.

[1] See *PTT* and I. Gershevitch's review in *Asia Minor* II (1951), pp. 133ff.

[2] "The Old Iranian Calendars Again", *BSOAS* XIV (1952), 603–11; see p. 604.

[3] According to Bīrūnī's "Chronology" (Arabic text, ed. Sachau, p. 14, Sachau's translation, p. 17), the "appearance of Zoroaster" (*waqt ẓuhūrihī*) occurred 258 years before the *Era of Alexander*, beginning on 1 October 312 B.C.; this leads to 570 B.C. as the year of advent of the new religion. Taqizadeh, Henning and Hinz count the 258 years back from Alexander's conquest of Persia, 330 B.C., whence they arrive at the year 588 B.C.; but this date is not convincing, as Alexander's conquest by itself plays no role whatever in the accepted chronology.

Avestan calendar of month names called after deities not worshipped by Zoroaster: these seem to belong to the oldest Avestan stock and may have been incorporated in Zoroastrianism quite soon after the death of the prophet; (2) the fact that Yasna 3.11, ascribed equally to early Avestan times, lists the names of six "seasonal deities" as *ratus* (judges) of Aša, which subsequently play an important role (still to be discussed) in the Later Avestan calendar, where they are called the six *gāhānbārs*; they are commonly interpreted (thus still by Taqizadeh)[1] as the indicators of six unequal seasons of an approximately tropical year. According to Taqizadeh, "nothing is known of the means by which the seasons were kept in their astronomic positions in the year. Whether this was a lunisolar year, as some scholars had presumed, or a year of 360 days with a periodic intercalation in the manner of the 'Pēshdādian' year mentioned by Bīrūnī,[2] as others had supposed, is open to conjecture. The year began probably with the summer solstice, on the day immediately following the *Maiδyōišəma* ('midsummer') festival."

III. 14. Taqizadeh's pessimistic view as to the impossibility of clearing up the origin of the gāhānbārs is shared by all historians, earlier and modern. An explanation that in itself has a very high degree of probability, however, offers itself as soon as we apply to the problem the rules found valid for the determination of solar dates in the prehistoric and early historic (Babylonian) periods, as illustrated at length in Parts I and II.

Everything points to the gāhānbārs, which subsequently, in the Later Avestan calendar, were celebrated as festivals of 5-days' duration each, having been understood not as "seasons", but as six well-defined solar dates forming the solar "skeleton"[3] of the year, which until the acceptance of the Babylonian calendar in Achaemenian times in all probability was a primitive lunisolar one, as was the case with practically all calendars in Antiquity.

[1] See Taqizadeh, *op. cit.*, p. 605.

[2] Bīrūnī's "Pešdādian" year ("Chronology", p. 11, transl., p. 13) is a year of 12 months of 30 days with an intercalary month every 6 years and two intercalary months every 120 years. 120 years thus comprise 1,440 + 21 = 1,461 months = 43,830 days. The same number of days is contained in 120 Julian years: $365\frac{1}{4} \times 120 = 43{,}830$. There is no reason to believe that such a "round year" of 360 days ascribed here to the mythological Persian rulers was ever in use, either in Iran or elsewhere. It is a learned construction devoid of historical foundation, but nevertheless widespread even among recent historians.

[3] See above II. 6, p. 738.

The names given in Yasna 3.11 are the following:

I	Maiδyōizarəmaya,	IV	Ayāθrima,
II	Maiδyōišəma,	V	Maiδyāirya,
III	Paitiš.hahya,	VI	Hamaspaθmaēdaya.

They reappear in the same sequence in *Āfrīnakān* 3.7–12, with two important additional pieces of information: (1) the numbers of days comprised between each two consecutive gāhānbārs, and (2) the days of the months corresponding to each gāhānbār in the Later Avestan calendar, valid for the time of composition of the passage incorporated in the *Āfrīnakān*.[1] Exactly the same differences result from the days in the Later Avestan calendar as reported by Bīrūnī in his "Chronology".[2]

While (2), i.e. the relative position of the gāhānbārs in the movable Later Avestan calendar, will serve us later[3] to establish the approximate years of origin of the *Āfrīnakān* passage and of the period fitting Bīrūnī's data, (1), i.e. the different but invariable time-spans between the gāhānbārs, will furnish the clue to the original meaning and function of the gāhānbārs themselves.

The time-spans are as follows:

45 days from VI Hamaspaθmaēdaya	to I Maiδyōizarəmaya,
60 days from I Maiδyōizarəmaya	to II Maiδyōišəma,
75 days from II Maiδyōišəma	to III Paitiš.hahya,
30 days from III Paitiš.hahya	to IV Ayāθrima,
80 days from IV Ayāθrima	to V Maiδyāirya,
75 days from V Maiδyāirya	to VI Hamaspaθmaēdaya.

III. 15. As for the original significance of these words, only two of them have a clear bearing on astronomy: Maiδyōišəma means "midsummer", i.e. summer solstice, and Maiδyāirya, "midwinter" or winter solstice. Of the remaining four – this is indicative – Maiδyōizarəmaya originally denoted a spring festival, Paitiš.hahya the time of harvest, Ayāθrima the return of cattle from the pasture-grounds, and Hamaspaθmaēdaya the time of bestirment, i.e. the beginning of outdoor or field work.[4] They all thus refer to approximate solar dates.

[1] Leaving open the question as to whether the *Āfrīnakān* as a whole originated at the time concerned; cf. p. 782, n. 1.

[2] Pp. 215–33 (transl., pp. 199–219).

[3] See V. 1–2, pp. 781–3.

[4] See I. Gershevitch, *Festschrift Oswald Szemerényi* (Amsterdam, 1979), 294.

In the 6th and 5th centuries B.C., the difference in days between the summer and winter solstices was actually 180.5, and that between winter and summer solstice, 184.75, while the opposite: 185 and 180 days, respectively, results from the *Āfrīnakān* data; but considering the errors arising necessarily in determining the solstices, as pointed out above,[1] this inaccuracy is not surprising.

In view of the predominant role which the annual risings and settings of particularly conspicuous stars have played in the Middle East since the dawn of civilization, the surmise that the gāhānbārs too were originally determined by them has a high degree of probability. Since in trying to verify this the results obtainable will always involve an error of a day or two at least, the graphical method, i.e. the use of a star chart constructed by analogy with diagram 1 (Part II, p. 721) for *c.* 530 B.C. and for an horizon for latitude 30°, will be amply sufficient and by far preferable to the computational, the more so because it shows at one glance which of the stars, for each of the gāhānbārs, may have served as a time indicator. As for the latitude chosen (30°, Persepolis) a variation of 3° N or S, or even more, will not affect perceptibly the dates of annual risings and settings of stars near the ecliptic; only for stars standing far north or south of it will the dates undergo considerable changes.

Starting now from V, Maiδyāirya, winter solstice,[2] on 21 December (Gregorian), and applying the differences resulting from Afrīnakān and Bīrūnī, we find that VI falls 75 days later, on 6 March, then I, 45 days later, on 20 April; II, 60 days later, on 19 June; III, 75 days later, on

[1] See III. 1, pp. 739–40. Bīrūnī, p. 216 (transl. 201), asserts that the solstices are more easily determinable than the equinoxes and that even an unskilled observer, measuring the variation of the shadow length, "cannot possibly mistake the day of the solstice". In another context, however (p. 184, transl. p. 167), he says the contrary: modern astronomers know that it is extremely difficult and next to impossible to determine the times of the two solstices; cf. W. Hartner and M. Schramm, "Al-Bīrūnī and the Theory of the Solar Apogee", in A. C. Crombie (ed.), *Scientific Change* (London, 1963), pp. 206–13. Against his first assertion it must be said that the variation of declination about the solstices is *c.* 25″ in one day, and less than 2′ in three days, which excludes direct measurement even if a large gnomon is used. Satisfactory results can be obtained only by employing the method of corresponding altitudes, possibly in use already in the 6th century since the solstices are found accurate to 2–3 days. More accurately observed was the spring equinox, as we have seen, witness the arrangement of the Babylonian calendar. Once determined with the aid of appropriate gnomon observations, however, the observation of annual risings and settings of stars, as discussed in the following, could serve as a convenient means to ascertain the four cardinal points of the year as well as other solar dates of special interest.

[2] This beginning, arbitrarily chosen, causes II (Maiδyōišəma) to fall on 19 June, too early by *c.* 3 days. In choosing the correct date of II (summer solstice) as a starting point, V (winter solstice) would fall too late by the same amount. In any case, owing to the wrong differences between II and V (see above), recourse to a compromise is unavoidable.

2 September; IV, 30 days later, on 2 October; finally, again V, 80 days later, on 21 December, whereby the 365 days of the year are completed. Adding to these six gāhānbārs the day of spring equinox on 21 March, which we have seen played a predominant part in establishing the Babylonian and Old Persian lunisolar calendars, and using for it the abbreviation *N*,[1] we thus have the following sequence:

N (Naurōz) 21 March
I (Maiδyōizarəmaya) 20 April
II (Maiδyōišəma) 19 June
III (Paitiš.hahya) 2 September
IV (Ayāθrima) 2 October
V (Maiδyāirya) 21 December
VI (Hamaspaθmaēdaya) 6 March

III. 16. A first test based on the assumption – illusory of course when applied to a mountainous area like Iran – of an horizon even and level in all directions of the windrose, yields encouraging results only for the phenomena observable at the western horizon (heliacal and cosmical settings), while those occurring in the East (heliacal and acronychal risings) do not permit us to draw any convincing conclusions. Things become different, however, if we assume that the observations were made on the site where the great Achaemenian palace was erected. According to recent topographical investigations,[2] the western horizon of Persepolis is practically even (average elevation *c.* 1°), while the eastern mountain range has an average elevation of 12°, which causes rising stars to become visible *c.* 12 to 14 days later than would be the case on a level horizon.

For the *true* geographical horizon of Persepolis then the prominent stars marking by their annual risings and settings Naurōz and the 6 gāhānbārs are listed in Table 2, where the following symbols are used:

HR = heliacal rising, i.e. first visible rising above the eastern mountains at dawn;
AR = acronychal rising, i.e. last visible rising above the eastern mountains at twilight;

[1] The letter *N* is to symbolize the modern term Naurōz, leaving the question open whether the Old Avestan year began with spring equinox or, as has been conjectured from the astronomical orientation of the palace of Persepolis, with summer solstice.

[2] See W. Lentz and W. Schlosser, "Persepolis – Ein Beitrag zur Funktionsbestimmung", in *XVII Deutscher Orientalistentag 1968* (*ZDMG* Supplement I.3, 1969), pp. 957–83.

HS = heliacal setting, i.e. last visible setting below the level western horizon at twilight;

CS = cosmical setting, i.e. first visible setting below the level western horizon at dawn.

In order to permit direct comparison with our modern calendar, the dates are given in Gregorian style, for *c.* 530 B.C.; due to the slowness of precession and the impossibility of computing under the given conditions the annual phenomena with a high degree of accuracy, they are valid *grosso modo* for the whole period *c.* 580–480, whence no conclusion can be drawn from them as to the first time they were observed and recorded. In this context it should be noted that also the differences between the gāhānbārs are given in round figures in the extant texts (45, 60, 75... days). It seems certain, however, that these annual phenomena were paid attention to before the time when the site for the great palace was selected, since the building's astronomical orientation, as was recently ascertained, can no longer be doubted. For, the longitudinal axis of the rectangular great palace has a deviation from the North–South line of 20.5° towards NNW, which has the effect that the rays of the Sun rising at summer solstice above the mountains meet the eastern wall at right angles, which then for a short moment causes the shadows of the columns standing in one and the same row to form a continuous band.[1] The importance of summer solstice (gāhānbār II), which originally may, but would not necessarily, have marked the beginning of the year, thus seems doubly stressed.

As can be seen from our table, it was a limited number of particularly conspicuous stars, less than 30, which announced the gāhānbārs by their annual risings and settings.

III. 17. Without exception these stars and constellations belong to the age-old stock of Sumero-Akkadian catasterisms as recorded in the ^{mul}APIN tablets[2] as well as, much later, still on medieval astrolabes. In order to illustrate their varying functions they are listed once again in Table 3 together with their Akkadian names and their annual phases indicating the 6 gāhānbārs and spring equinox. As for the latter, as said before, my discussion of the Babylonian and Old Persian year[3] will have

[1] Cf. Lentz–Schlosser, p. 971.

[2] For their identification see van der Waerden, "Babylonian Astronomy II. The Thirty-six Stars", *JNES* x (1949), pp. 414–24; for their prehistory I refer to Hartner, "The Earliest History of the Constellations".

[3] See III. 3–5, pp. 742f.

shown with sufficient clarity that it played a predominant role in regulating the Babylonian lunisolar year, to which the Old Persian was finally adapted.

This table, arranged according to increasing right ascensions, clearly demonstrates that the gāhānbārs were determined preponderantly by evening, not by morning observations. Indeed, only the two columns listing acronychal risings and cosmical settings – both observable after sunset – offer complete sequences of the 6 gāhānbārs in their normal order: the former begins with no. 15, Antares, announcing mid-winter (I), and ends with no. 13, Spica, announcing the last gāhānbār (VI); the latter (which includes spring equinox, *N*, marked by the cosmical setting of Spica) starts with no. 14, α Librae (I), and ends with no. 12, Denebola (VI). In the 6th century, as pointed out before, the age-old Lion–Bull combat situation (the triumphant Lion culminating while the Bull starts disappearing in the rays of the setting sun, see II 5, p. 737) occurs only 6–7 days *after* the equinox. During the preceding weeks, the Pleiades' gradual approach to the setting sun foretells the advent of spring equinox, the exact day of which is then determined by the first visible setting of ab.sin, the "Corn Ear", at dawn. This event, marking the beginning of the light half of the year, seems important enough to account for the multitude of Lion–Bull combat reliefs decorating the Apadana of Persepolis.

III. 18. As a striking fact I mention finally that the royal star, Regulus (α Leonis) does not figure in our list and that Sirius' heliacal rising plays no role whatsoever. For the mountainous horizon of Persepolis it occurred on 17 July (Gregorian) = 23 July (Julian).[1] It may not have been incorporated into the gāhānbār system because it marked no solar date of agricultural interest. But it was doubtless paid due attention already in the Old Avestan calendar, as borne out by the Later Avestan, whose 4th month, Tištryehe, carries the name of this most famous star.[2] As we have seen,[3] an intercalation rule for the lunisolar Babylonian calendar recorded in Seleucid texts, but valid also for earlier times, decreed that the heliacal rising of Sirius was to fall in the 4th month, Du'ūzu. Now in the critical 19th year of Darius (503–502 B.C.), the beginning of the Babylonian year, on 1st Nīsannu (27 March, Julian style), coincided with the beginning of the Later Avestan month

[1] For a level eastern horizon, 11/16 July.

[2] On its alternative name **Tīriya* (whence *Tīr* in later Persian, see p. 760, IV, cf. also p. 775).

[3] See III. 2, p. 741.

Fravašinąm, whence the subsequent months in both calendars ran practically parallel: the 1st Du'ūzu fell on 23, the 1st Tištryehe, on 25 June. As a consequence, the heliacal rising of Sirius took place at Persepolis at the very end of these months: 29 Du'ūzu and 27 Tištryehe respectively. This being an established fact for the outset of the Later Avestan calendar, the assumption ventured above seems justified that similar conditions ruled already in the Old Avestan, in other words, that the lunar month in which Sirius had its heliacal rising also carried its name.

III. 19. So far, apart from the last remark, we have been speaking only of the solar terms: spring equinox and the 6 gāhānbārs, which regulated the recurring seasons. As I have shown, the principle employed – the observation of star phases – dates from the early settlers, about 4000 B.C. or even before. As concerns our case, the probability is great that already in remote antiquity the Persepolis plateau was given preference for making observations in the sense described.[1]

Of course to make a calendar more is needed than solar terms alone. But about this one no more can be said than that it must have been crudely lunisolar, as was the case with all others, always excepting the Egyptian. For its pre-Zoroastrian phase, Taqizadeh[2] employs the term "Magian". Four of the month names, called after old Iranian deities including Tištrya-Sirius, were taken over by the Later Avestan calendar. We shall see in Part IV that all four of them in addition became deities after whom four of the 30 days of the Later Avestan months were named. The assumption of a continuity thus seems well founded.

PART IV. THE LATER AVESTAN CALENDAR

IV. 1. In his *De Emendatione Temporum* (1583), basing his view on the scanty evidence he had at hand, Joseph J. Scaliger had claimed that the Later Avestan calendar must have been borrowed, either directly or through an intermediary, from the Egyptian. His views were shared – except for those who answered the question with a *non liquet* – by most of the later authors on the subject, from Ideler over Benfey, Stern, von

[1] An Elamite inscription on the southern (outer) terrace wall at Persepolis (*DPf* Darius Persepolis *f*) tells us about "this fortress (Persepolis) where previously none had been built"; see G. G. Cameron, "The Persian Satrapies and Related Matters", *JNES* XXXII (1973), 54. This statement does not of course exclude that the plateau had previously been the site from which observations of the stars were made.

[2] "The Old Iranian Calendars again", p. 606.

Gutschmid, Ginzel, Marquart (Markwart), Taqizadeh, down to the present writer. Divergent theories, however, have been propounded in two articles by E. J. Bickerman[1] and Mary Boyce.[2] Both bear witness to remarkable historical and philological learning and contain some valuable factual information. However, the latter author's conclusions especially, owing to her lack of both mathematical insight and familiarity with the elements of astronomy and chronology, cannot be taken seriously.[3]

As to Bickerman, I subscribe with some reserve to his conclusions (p. 207), going in one case even beyond them, though without sharing his opinion (p. 204) that all efforts to establish a plausible date for the introduction of the 365-day vagabond year are vain; he is clearly not aware that his equation "4 Shahrevar = 4 Addaru and 8 Mihr = 8 Nisanu" (p. 206), which he interprets erroneously, bears witness to the calendar's consistent use throughout the ages. I agree of course that the Achaemenians used the Babylonian lunisolar calendar (Bickerman offers proof of its existence down to 401 at least) and that it remained in use during the Arsacid rule; I add that it appears to have continued even well into Sasanian times. But I claim against him that the 365-day vague year was in continuous use, side by side with the lunisolar, from 503 B.C. onwards, through the Achaemenian, Seleucid, Parthian and Sasanian periods, and after the Muslim conquest until the Jalālī reform of 1079 and beyond, practically down to our time.

IV. 2. The Islamic sources from which information pertinent to the structure of the Later Avestan calendar can be drawn are scanty but sufficiently clear to serve as basis for a mathematical evaluation.

The earliest authors on the subject are Abu'l-Ḥasan Kūšyār b.Labbān al-Jīlī (*c.* 971–1029)[4] and his contemporary, Bīrūnī. According to Abu'l-Ḥasan Kūšyār's astronomical Tables (probably *al-zīj al-bāligh*, Book I),[5] following Ideler's German translation,

[1] "The 'Zoroastrian' Calendar", *ArOr* xxxv (1967), pp. 197–207.

[2] "On the Calendar of the Zoroastrian Feasts", *BSOAS* xxxiii (1970), pp. 513–39; still upheld by Mary Boyce in her *History of Zoroastrianism* ii (Leiden–Köln, 1982), 244, n. 151.

[3] Among others, she advocates the existence of a Zoroastrian 360-day solar year differing consistently by 5 days from the 365-day solar year (note that both are called *solar*) which she claims was introduced by the Sasanians (p. 515); she operates with the Pešdādian year (see p. 750, n. 2) which she thinks Bīrūnī confused with the Parthian year (!), and claims that it was a 360-day year *without modification* (my italics), in spite of the fact that Bīrūnī says clearly enough that an intercalation of a 30-day month was necessary every 6, and two such intercalations, every 120 years.

[4] H. Suter, *Die Mathematiker und Astronomen der Araber* (Leipzig, 1900), p. 83, no. 192.

[5] See Suter, *Nachträge und Berichtigungen zu "Die Mathematiker..."* (1902), p. 168. The above text is an English rendering of the quotation contained in F. K. Ginzel, *Handbuch der mathematischen*

each Persian month has 30 days, except for Asfendārmedmāh, which has 35. The year thus has 365 days. The 5 surplus days of Asfendārmedmāh (i.e. the epagomenae) are called *al-mustaraqa* ["the stolen days"]. The Persian year is *c.* one-quarter day shorter than the solar year. This makes one day in four years, and one month in 120 years. As a consequence the Persians from the remotest time intercalated a month every 120 years, the year thus comprising 13 months. They counted the year's first month twice, once at the beginning and once at the end of the year, and attached the epagomenae to the intercalated month. The first month of the year was that in which the Sun entered the sign of Aries [correctly, "travelled through", literally "put up at"; the Arabic text has "*al-šahr alladhī taḥillu fīhi'l-ḥamal*"]. Every 120 years the 5 days and the beginning of the year thus advanced by one month. At the time of Kisrā b. Qubād Anūširwān (Khusrau I, 531–79), the Sun reached ["travelled through", *taḥillu*] Aries in Ādhārmāh, and the 5 epagomenae [*al-khamsa*] had their place at the end of Ābān [*wa'l-khamsa mauḍū'a fī ākhir Ābān*]. When 120 years later the dynasty of the Persians came to an end... the rule was no longer observed, whence the 5 days remained attached to Ābānmāh till the year 375 of the era Yazdagird [A.D. 1006], when the Sun entered Aries on the 1st day of Farvardīnmāh; then the 5 days were attached to Asfendārmed [i.e. the 12th month].

Bīrūnī's account is essentially the same; in particular he mentions in this context the 120-years' intercalation period, but not that the intercalary month at the end of the year is called by the same name as the first (Farvardīn).[1] On the contrary he says:

Then he [Zoroaster] ordered people in all future times to do with the day-quarters the same as he had done, and they obeyed his command. They did not call the intercalary month by a special name, nor did they repeat the name of another month, but they kept it simply in memory from one turn to another. Being, however, afraid that there might arise uncertainty as to the place, where the intercalary month would have again to be inserted, they transferred the five Epagomenæ and put them at the end of that month, to which the turn of intercalation had proceeded on the last occasion of intercalating. And as the subject was of great importance and of general use to high and low, to the king and to the subjects, and as it is required to be treated with knowledge, and to be carried out in conformity with nature [*i.e.* with real time], they used to postpone intercalation, when its time happened

und technischen Chronologie I (Leipzig, 1906), p. 291; Ginzel in turn quotes from L. Ideler's *Handbuch* (same title as Ginzel's) II (1825–6), pp. 547 and 624 (Arabic text). Abu'l-Ḥasan, as is seen, wrote his treatise after the calendar reform of A.Y. 375 = A.D. 1006, while Bīrūnī wrote *al-Āthār al-bāqiya* ("Chronology of Ancient Nations") shortly before, in A.D. 1000. Bickerman's assertion ("The 'Zoroastrian' Calendar", p. 199, with reference to C. Brockelmann, *Geschichte der Arabischen Literatur*, 2nd suppl. I (Leiden, 1943), p. 253) that Abu'l-Ḥasan died in 985 is obviously wrong; Brockelmann, 1st suppl. I (Leiden, 1937) mentions 375/985 as the year of death of Ibn al-A'lam, whom Abu'l-Ḥasan cites.

[1] "Chronology", p. 44 (transl., pp. 54–6).

to occur at a period when the condition of the empire was disturbed by calamities; then they neglected intercalation so long, until the day-quarters summed up to two months. Or, on the other hand, they anticipated intercalating the year at once by two months, when they expected that at the time of the next coming intercalation circumstances would distract their attention therefrom, as it had been done in the time of Yazdajird ben Sâbûr, for no other motive but that of precaution. That was the last intercalation which they carried out, under the superintendence of a Dastûr, called Yazdajird Alhizârî. Hizâr was an estate in the district of Iṣṭakhr in Fârs, from which he received his name. In that intercalation the turn had come to Âbân Mâh; therefore, the Epagomenæ were added at its end, and there they have remained ever since on account of their neglecting intercalation. (pp. 55.31–56.12).

This report sounds perfectly reasonable and trustworthy, not only because it makes circumstantial mention of the official supervising this last intercalation, which thus must have taken place about A.D. 400 (Yazdagird I, the son of Šāpūr III, reigned from 399–420), but also because it does not contradict the account of Abu'l Ḥasan who only states that under Khusrau I the Sun travelled through Aries in Ādhārmāh, not that an intercalation was carried out in his reign. And true enough, in 531, the first year of Khusrau's reign, the Sun reached Aries on 7 Ādhār, and in 579, his last year, on 19 Ādhār. That the year began with the spring equinox is moreover confirmed by Bīrūnī, who in the passage preceding the one cited, expressly says that

the Persians believe that the beginning of their year was fixed by the creation of the first man, and that this took place on the day Hurmuz [i.e. the 1st day] of Farwardîn Mâh, whilst the sun stood in the point of the vernal equinox in the middle of heaven. This occurred at the beginning of the 7th millennium, according to their view of the millennia of the world.

and that the original order was restored by Zoroaster.[1]

Two more passages of much later date (14th century) by Quṭb al-Dīn al-Šīrāzī and Šāh Khuljī yield no additional information.[2]

THE CIVIL AND THE VIHĒČAKĪK YEARS

IV. 3. It results from these reports that two year forms were in use simultaneously, both having 12 months of 30 days each plus 5 epagomenal days at the end and coupled in such a way that the

[1] "Chronology", p. 45 (transl., p. 55): "When Zoroaster arose and intercalated the years with the months, which up to that time had summed up from the day-quarters, time returned to its original condition."

[2] See T. Hyde, *Historia religionis veterum Persarum* (Oxford, 1700), Ch. 17, pp. 203f., and Ginzel, *Handbuch* I, pp. 290f.

beginnings of the months and the epagomenae always ran parallel. One of them, the civil, which we know continued in use after the downfall of the Sasanian empire, had no intercalation, whence its beginning consistently receded by one day every 4 years from a given solar (to be more exact: Julian) date, say spring equinox. The other, called the *vihēčakīk* year in Pahlavī texts, served religious purposes (note that Bīrūnī ascribes its inauguration to Zoroaster); it added one intercalary month, (allegedly) every 120 years,[1] with the effect that for the next period of 120 years (years 121–240) the first religious month coincided with the second civil, then for the years 241–360 with the third, etc. Once, still in Sasanian times, the beginning of the religious year fell to the 8th month (Ābānmāh) and the epagomenae became attached to it, the procedure came to an end, so that the era of Yazdagird operated thenceforth with the year form inherited from the earlier Sasanian rulers, in which the epagomenae remained fixed after Ābānmāh.

The intercalation scheme, in which the years of Bīrūnī's 116-year period are given in brackets, is illustrated by Table 4.

IV. 4. To the modern names used in Table 4, which in the following will be given preference even for the earlier and earliest phases of the calendar, correspond the following Pahlavī and Avestan forms.[2]

	Modern Persian ·	Pahlavi	Avestan
I	Farvardīn	Fravardīn	Fravašinąm
II	Ordībehešt	Ardvahišt	Ašahe vahištahe
III	Khordād	Hordād	Haurvatātō
IV	Tīr	Tīr	Tištryehe
V	Mordād	Amurdād	Amərətātō
VI	Šahrīvar	Šahrēvar	Xšaθrahe vairyehe
VII	Mehr	Mihr	Miθrahe
VIII	Ābān, Abān	Ābān	Apąm
IX	Āḏār, Āḏar	Ādur	Āθrō
X	Dei	Dai	Daθušō
XI	Bahman	Vahman	Vaŋhave manaŋhe
XII	Esfendārmoḏ	Spandarmad	Spəntayå ārmatōiš
Epagomenae	Panja	5 rōz i gāhānīk	5 Gāθā days

[1] This intercalation period, founded on Abu'l-Ḥasan Kūšyār and on the one passage cited from Bīrūnī, will prove to be only a rough approximation. The correct period, as results from another passage in Bīrūnī (see below), is 116 years. The proof for this fact will be given later. Until then I shall operate with the schematic period of 120 years.

[2] [The Sogdian month-names and day-names, on whose relationship to those of the Later Avestan calendar see W. B. Henning, *BSOAS* XXVIII (1965), 251, will be found listed by Henning in *Orientalia* VIII (1939), 94f.; cf. p. 775, n. 1. The Khotanese month-names are given by H. W. Bailey in *Khotanese Texts* IV (Cambridge, 1961), p. 11, the Cappadocian ones by Paul de Lagarde, *Gesammelte Abhandlungen* (Leipzig, 1866), pp. 258ff. See also *CHI* III, pp. 814–15. Ed.]

For the epagomenae modern Persian usually employs the Arabic term *khamsa-yi mustaraqa*, "the five stolen days", which reflects Middle Persian usage (see p. 748, n. 1).

The scheme given in Table 4 is in accordance with Abu'l-Ḥasan's account, which prescribes the insertion of an intercalary Farvardīn II at the end of the year, in other words, after the epagomenae of year 120. Thereby in the civil calendar, the month Farvardīn is preceded and followed by 5 epagomenal days, and so is the intercalary Farvardīn II in the religious calendar. This results of necessity from the transposition of the epagomenae from their original position at the end of one year to the beginning of the next. By omitting the first set of epagomenal days and thus making Farvardīn (civil) 121 = Farvardīn II (religious) 120 follow immediately after the month Esfendārmoḏ, the length of the civil year 120 would have been reduced from 365 to 360 days, and of the corresponding religious year 120, from 395 to 390 days, while later intercalations (years 240, 360...) would not of course affect the year-length as they involve only a transposition of the epagomenae within one and the same year. There would thus have resulted a loss of 5 days in both calendars throughout the ages. As will be demonstrated,[1] no such error can have been committed because the length of the civil year, counting from 1st Farvardīn to 1st Farvardīn can be proved to have remained constant since the very day on which it was started. But there is one fact from which it may be inferred that opinions differed among the officials or priests responsible for the first intercalation, which must have been decreed some time in the first half of the 4th century B.C.: the extension from originally one to subsequently five days of each of the six gāhānbārs and of other feasts, and to eleven days (the epagomenae and the first six days of Farvardīn) in the case of the combined Farvardigān-Naurōz, always counting the last day as the decisive one.[2]

[1] See IV. 11, pp. 766f.

[2] Bickerman, "The 'Zoroastrian' Calendar", p. 203 has no high opinion of the capacity of the Persians in the 5th century B.C. to effect computations that would serve to ensure a satisfactory functioning of the religious calendar in the way described. In this context he retells Herodotus' story (IV.98) about Darius giving a thong with 60 knots to the Ionian tyrants and telling them to untie one knot a day so as to know when they might expect him back. He takes this for proof of lack of mathematical insight on the part of the Persians. In fact, however, it proves nothing, for even a skilled mathematician may get confused without such a primitive aid to memory. Counting on the fingers and mathematics are quite different things. The tyrants, moreover, were not Persians but Ionian militaries at the dawn of Greek history, a century before the first intercalation became an issue in Greece. The Persians, witness their well-functioning *lunisolar* calendar in use by then, had already familiarized themselves with the learning of their Babylonian teachers.

IV. 5. However, another passage in Bīrūnī's "Chronology", consistently overlooked or perhaps not taken seriously by earlier students, is of the greatest importance although at first sight it may seem no more than a learned conjecture by a mathematician; it is found on p. 11 of the Arabic text[1] and runs in Sachau's translation as follows:

[The Persians] reckoned their year as 365 days, and neglected the following fractions until the day-quarters had summed up in the course of 120 years to the number of days of one complete month, and until the 5th parts of an hour, which, according to their opinion, follow the fourth parts of a day (i.e. they give the solar year the length of $365\frac{1}{4}$ days and $\frac{1}{5}$ hour), had summed up to one day; then they added the complete month to the year in each 116th year. This was done for a reason which I shall explain hereafter.

The explanation promised here is not found in the text as it has come down to us; in all probability it was contained in the *lacuna* on p. 45;[2] fortunately it can be reconstructed.

A similar, though less accurate, statement is found in the *Dēnkart*, at the end of the 3rd book (ed. Madan (Bombay, 1911), 402–5). It reads as follows (rendered into English from Nyberg's translation):[3]

They say that the fractions accumulating from year to year, viz., those hailing from the six hours *and some minutes* [my italics], which go beyond the 365 days of each year, make exactly one day in four years; in 40 years 10 days; in 120 years, one month; in 600 years, 5 months; and in 1440 years, one year. The *fractions of the hour*, in the course of time, accumulate to a day; it is the period of time which is gradually formed, in the course of many years, by adding up the minutes which exceed the six hours, that is to say, the hours which [in their turn] exceed the days of the year.

Here evidently Bīrūnī's "$\frac{1}{5}$ hour", i.e. 12 minutes, is meant.

By contrast, in dealing with the Sogdian festivals ("Chronology", Ch. 10, p. 220), Bīrūnī says:

The ancient Persians used a solar year of 365 days 6 hours 1 minute, and it was their universal practice to reckon these 6 hours *plus* the 1 minute as a unit [i.e. to disregard the 1 minute in reckoning].

This excess of one single minute is astounding. The Arabic text, avoiding, as in most if not all similar cases found in *al-Āthār al-bāqiya* (contrary to other Bīrūnī texts), the term *daqīqa* for "minute", has for the excess over 365 days *wa-aktharu min rub'i yawmin bi-juz'in min sittīna juz'an min sā'atin*. By admitting of a scribal error: *min sitta ajzā'*, instead of *min sittīn juz'*, we would have one-sixth hour or 10 minutes, which

[1] Transl., pp. 12–13.
[2] Transl., p. 55.
[3] H. S. Nyberg, *Texte zum Mazdayasnischen Kalender* (Uppsala, 1934), pp. 30/31–32/33.

comes close enough to the above-mentioned value "one-fifth hour" (expressed there in the usual way by *khums al-sā'a*), and which yields an even better value for the sidereal year: 365.2569 (see IV. 7).

With or without this conjecture we would find ourselves confronted with the strange fact that Bīrūnī, depending on the case, operates with widely different values for the sidereal year.

IV. 6. Up to now we were concerned only with an alleged solar year of $365\frac{1}{4}$ days (the later "Julian" year) to which the vague year of exactly 365 days had to be adapted by regular month-intercalations. This year-length, however, is only an approximation to either of the two year-forms that result from astronomical observation: the *tropical* year, T = 365.24220 days, which is *c.* 11 minutes shorter, and the *sidereal*, S = 365.25636, which is *c.* 9 minutes longer, than the Julian. The tropical, which alone keeps pace with the seasons, measures the Sun's revolution from vernal point to vernal point or, more generally, its return to one of the equinoctial or solstitial points. It was not distinguished from the sidereal by the Babylonians, even in the Seleucid period, although astronomers doubtless had an idea that it was shorter than the sidereal. The first who determined its length with fair accuracy was Hipparchus (about 130 B.C.). By contrast, the sidereal year, i.e. the Sun's return to a given fixed star, say Regulus or Spica, must have been known at the latest in the 6th century to exceed $365\frac{1}{4}$ days. Seleucid astronomers knew it with astounding accuracy. In their elaborate tables they operate with two slightly different values for its length, one of them coming close to the correct one: the one, which figures in tables belonging to the so-called "System A",[1] has $S_A = 365.2679$, the other ("System B"), $S_B = 365.2595$. These values for the sidereal year must have resulted from observations, stretching probably over centuries, of star phases, such as those listed in Tables 2 and 3.

IV. 7. Let us now scrutinize Bīrūnī's statement. The year he says has a length of $365\frac{1}{4}$ days plus the fifth part of an hour, in other words, 365 days, 6 hours and 12 minutes. Expressed in fractions of a day, this corresponds to 365.2583 which, compared with the correct value, S = 365.2564 (see above), is 0.0019 days, or 2.74 minutes, too high. The error is very small; it would accumulate to one day in *c.* 530 years. Note, moreover, that it is nearly identical with, in fact only 100 seconds short of, the Babylonian $S_B = 365.2595$.

[1] For further information see Neugebauer, *The Exact Sciences*, Ch. V, and van der Waerden, *Anfänge der Astronomie*, pp. 114, 172; for a numerical evaluation, in particular, see Hartner's review of the latter in *Gnomon* XLII (1971), p. 534.

This we compare with Bīrūnī's intercalation rule. After each 116th year he says one month of 30 days is inserted. This results in a year length of $365\frac{30}{116} = 365.2586$ days, which differs from the above value, 365.2583, by 26 seconds only. Since an intercalation of 30 days after each 115th year yields 365.2601, and one after each 117th year, 365.2564 (which, incidentally, would be the correct one, S, according to our modern knowledge), the prescribed intercalation period of 116 years is the only one that accords with Bīrūnī's length of the sidereal year.[1]

EXCURSUS: THE OLD EGYPTIAN YEAR

IV. 8. As an excursus I insert here a brief discussion of the old Egyptian calendar. As said in what precedes, its relationship to the Later Avestan calendar has been under debate since Scaliger's time, but no conclusive mathematical proof has so far been given either in the affirmative or in the negative.

Like the Later Avestan calendar, which it precedes by far, the Egyptian calendar, in use already by the beginning of the 3rd millennium,[2] operated with an invariable year of 365 days subdivided into 12 months of 30 days plus 5 epagomenal days at the end of the year. In accordance with the climatic peculiarities of the country, the year was divided into 3 seasons: the time of the Nile flood, the time of sowing and the time of harvesting, and each season was supposed to comprise 4 months, as follows:

Time of Flood	Time of Sowing	Time of Harvesting
1 Thoth	5 Tybi	9 Pakhon
2 Phaophi	6 Mekhir	10 Payni
3 Athyr	7 Phamenoth	11 Epiphi
4 Khoyak	8 Pharmuti	12 Mesori
		(13) "Little month" of 5 days

[1] O. Neugebauer, *A History of Ancient Mathematical Astronomy* II (Berlin–Heidelberg–New York, 1975), p. 902, derives from Ptolemy's *Planetary Hypotheses*, as a basic parameter underlying all data referring to planetary motion, the length of the sidereal year, $S_p = 365;15,24,31,22,27,7$ days (sexagesimal fraction); converting this into a decimal fraction, we find $S_p = 365.2568119174$. This "hypercorrect" value is only 39 seconds too high compared with the modern, $S = 365.25636$; it is thus far better than the value indicated by Bīrūnī.

[2] The alleged "introduction of the Egyptian vague year on 19 July, 4241 B.C." when the first day of the year (1st Thoth) coincided with the heliacal rising of Sirius (see E. Meyer, *Geschichte des Altertums*, 2nd ed., vol. I, part 2 (Stuttgart–Berlin, 1909), pp. 29ff.), can no longer be maintained; see O. Neugebauer, "Die Bedeutungslosigkeit der Sothisperiode", *AO* XVII (1938), pp. 169–95.

The year, we see, was originally devised as a solar year beginning with the heliacal rising of Sirius (Eg. Sopdet, Gr. Sothis), which during several millennia announced the advent of the flood. But as in the case of the Later Avestan year, the 1st of Thoth gradually receded through the astronomical seasons, one day every four years, so that after 500 years ($4 \times 5 = 20$ for the "little month", and $4 \times 120 = 480$ for the preceding 4 months) it fell on a day in the solar calendar originally held by 1st Pakhon; another 480 years later it coincided with the original solar date of 1st Tybi, and again after 480 years it came back to its initial position determined by the heliacal rising of Sirius.[1] The Egyptian and the *civil* Later Avestan year, both of which ignore the astronomical seasons, are thus perfectly analogous.

It was not before the time of Augustus that the quarter-day error was accounted for by intercalations similar to those of the Julian calendar. This "Alexandrian year" was used by Ptolemy in one of his minor works, the *Phaseis*, so called for good reasons, because it deals with the annual phases (heliacal risings etc.) of stars, which depend on the solar, or more precisely, the sidereal, year. By contrast in the *Almagest* Ptolemy operates consistently with the old Egyptian year of 365 days, choosing as his epoch the 1st of Thoth, 747 B.C. (the year of the Babylonian king Nabonassar's ascent to the throne), which corresponds with the Julian date 26 February, 747 B.C., and counting consistently by years after Nabonassar. The reasons for this choice are obvious: a calendar based on a year of constant length is of great advantage to astronomical computations in which differences of days comprised between observations (e.g. of eclipses) made at far distant times are to be carried out.[2]

[1] For the sake of completeness it may be added that the "Sothis period" is never mentioned in hieroglyphic texts. Censorinus, in A.D. 239, and Theon of Alexandria, about 370, refer to it. The latter states correctly that in A.D. 139 the first day of Thoth coincided with the heliacal rising of Sirius, on 20 July. From this, reckoning back by periods of 1,460 years, he finds earlier coincidences to have occurred in the years (expressed according to modern usage) 1322, 2782 and 4242 B.C. This last date, supported by no historic evidence whatever, was celebrated by Meyer as "the earliest date in history".

[2] For the same reason modern chronology employs the so-called "Julian day count" (introduced by J. J. Scaliger and named after his father, Julius Caesar Scaliger) to which we shall have recourse occasionally in the ensuing demonstrations. Its epoch is a far remote date, 1 January, 4713 B.C., counted as day no. 0. Since 4713 B.C. is a leap-year, the 1st January of the next year will be no. 366, of the next, no. 731, etc. To the Era of Nabonassar, 26 February (= 1st Thoth) 747 B.C., corresponds no. 1448638; to 27 March 503 B.C. (spring equinox), no. 1537788; to the Era of Yazdagird, 16 June (= 1st Farvardīn), A.D. 632, no. 1952063; to 13 April (= 1st Farvardīn) A.D. 890, no. 2046233; to 15 March (= 1st Farvardīn) A.D. 1006, no. 2088573.

IV. 9. The questions to be answered now on the basis of what we have seen are the following three:

(1) Is the analogy between the Egyptian and the Later Avestan calendars purely accidental? If not, is it possible to establish the date when the two became linked together?

(2) Were the intercalations in the religious calendar made regularly until political vicissitudes, as referred to by Bīrūnī, put an end to regularity and finally stopped them altogether, after an anticipated eighth intercalation involving a transposition of the epagomenae after Ābānmāh? Is Bīrūnī's report trustworthy in maintaining that this last intercalation was decreed by or during the reign of Yazdagird I, the son of Šāpūr III (399–420)? If so, which of the two intercalation intervals, 120 or 116 years, is to be accepted as correct?

(3) Was the date 375 Yazdagird = A.D. 1006, for the redemption of the neglected four intercalations (in reality, five were due) by transposition of the epagomenae after the 12th month (Esfendārmoḏmāh), chosen at random, or does it bear witness to the remembrance of the old intercalary system having still been alive in learned Iranian circles?

IV. 10. To find a solution to these problems we, naturally, start from the only indubitable date connecting the Later Avestan calendar with the Hijra, and thereby also with the old Egyptian and the Julian calendars: the beginning of the era of Yazdagird III.

In A.D. 632 the first Farvardīn fell on Julian day (JD, see p. 765, n. 2) no. 1952 063, a Tuesday, corresponding with 21 Rabīʿ I, A.H. 11; moreover, with 1st Khoyak, year 1380 of the era Nabonassar; finally, with 16 June, A.D. 632.

The fact that in 632 the 4th Egyptian month, Khoyak, coincided completely with the 1st Later Avestan, Farvardīn, seems indicative because of the analogous structure of the two calendars. In order to ascertain, however, that this identity has prevailed throughout the ages (this is not a matter of course on account of the changing position of the epagomenae in the Later Avestan), we have recourse to the following consideration.

IV. 11. Let us assume that – probably about 500 B.C. – there ruled the same identity: Farvardīn = Khoyak, and let us for the sake of simplicity denote the Later Avestan month with Arabic, and the Egyptian with Roman numerals. We shall then have the concordances 1 = IV, 2 = V, etc., till 9 = XII, and the Egyptian epagomenae (XII*e*, attached to XII)

will correspond with the first 5 days of the Later Avestan 10th month (Daθušō = Dei), and thereafter, the 6th day of 10 with the 1st of I (Thoth). The effect will be that each of the Later Avestan months nos. 10, 11 and 12 falls 5 days ahead of the corresponding Egyptian, I, II and III. The concordance is restored only by the insertion of the Later Avestan epagomenae (12*e*), attached to 12 (Esfendārmoḏmāh). Thereafter the cycle starts anew with 1 = IV.

The first intercalation in the *religious* calendar (*c.* 120 years after the inception) involved a transposition in the *civil* of the epagomenae from the end of the year (12*e*) to the beginning of the next: they now become attached to 1 (Farvardīn), and will accordingly have to be denoted as 1*e*. Thus we have the equations 1 = IV as in the preceding period, but thereafter the Later Avestan epagomenae will fall on the first 5 days of V; then the first day of 2 (Ordībeheštmāh) will fall on the 6th of V, the 1st of 3, on the 6th of VI, etc., until by the insertion of the Egyptian epagomenae (XII*e*) after XII, which then coincide with days 26–30 of 9 (Āḏārmāh), the concordance is restored with 10 = I, 11 = II, 12 = III, and 1 = IV. Thus during this period, the Later Avestan months: 2 (Ordībeheštmāh) through 9 (Āḏārmāh) will all start on the 6th day of the corresponding Egyptian, V (Tybi) through XII (Mesori), and only the four months mentioned above (10 = I through 1 = IV) will be in perfect correspondence.

As can easily be seen, with each subsequent intercalation period the number of completely congruent months is increased by one: in the second we have 10 = I through 2 = V; in the third, 10 = I through 3 = VI; finally, in the eighth – the last – when the epagomenae (8*e*) became attached to 8 (Ābānmāh) we have 10 = I through 8 = XI. Only the ninth intercalation, which was never decreed, would have caused the epagomenae of both calendars to coincide, and with them, all other months: Farvardīn = Khoyak through Esfendārmoḏ = Athyr.

Thus a comparison of a civil Later Avestan date with an Egyptian is possible only if we know which of the eight intercalation periods is concerned. This would seem of purely theoretical interest since we have no other equation than the one mentioned, namely A.D. 632, 1st Farvardīn = 1st Khoyak. Nevertheless it will prove useful because it enables us, as will be seen, to verify some Later Avestan dates with the aid of the tables available for the Egyptian calendar.

IV. 12. The main, though not the only purpose of the preceding demonstration was to prove that, despite differences of 5 days occurring

on a great many occasions between the two calendars, the Later Avestan Farvardīn coincided at all times with the Egyptian Khoyak. This was true thus also at the time when the Later Avestan calendar came into being, and thereby the two calendars' close connection appears to be firmly established. Historically this needs no justification, considering the close relation between Persia and Egypt established after Cambyses' conquest of Egypt (525 B.C.).

Now Abu'l-Ḥasan tells us (see IV. 2) that the first month of the year originally was the one in which the Sun entered the sign of Aries – in other words, spring equinox. Although it has been claimed with more or less convincing arguments that the Later Avestan year originally started at winter solstice, with the month Daθušō-Dei, or even at summer solstice, I see no reason to doubt Abu'l-Ḥasan's trustworthiness. Let us therefore determine the period of 4 years[1] during which 1st Farvardīn = 1st Kḥoyak fell on the spring equinox. We find by an elementary computation that this was the case 1,134 to 1,137 Persian years before the Era of Yazdagird, i.e. in the years 505–502 B.C.,[2] when the day of the spring equinox was 27 March (Julian).

IV. 13. This critical period we now remember plays a crucial role in another context. In III. 4 I have shown that the year 503 B.C., the 19th year of Darius' reign, at one and the same time marked the end of the Babylonian calendar's octaëteris intercalation and the beginning of the new 19-year cycle, on the day of spring equinox, 27 March. We have seen, moreover (III. 9/10), that in the same year there occurred irregularities in the Old Persian lunisolar calendar, that can be explained as reflecting an uncertainty pertaining to this transition period.

The probability is therefore considerable that the Later Avestan calendar was started precisely then, on 27 March 503 B.C., with the first day of the month Fravašinąm-Farvardīn (no matter whether that name

1 During 4 years the Later Avestan and Egyptian calendar dates fall on one and the same solar (or Julian) date. In the 6th century B.C. spring equinox fell on 27 March (Jul.), in the 5th, on 26 March.

2 Taqizadeh, *op. cit.*, p. 603, concludes that the Egyptian calendar "was perhaps adopted by the Zoroastrian community of Iran at a time when the Egyptian New Year (the first day of the month Thoth) corresponded with the winter solstice, and the same day was made the beginning of the Iranian year and the first day of the month Daδv (Dai). This was the case in or about 504 B.C., on 26–7 December. In this same year the same day (27 December) happened to correspond also with the first day of the old Persian (Achaemenian) month Anāmaka (the 10th month) = Babylonian Ṭebētu." His claim, however, that in or about 504 B.C. the month Daθušō too started at winter solstice on 26–7 December, is erroneous. As demonstrated above, 1 Daθušō fell on the 1st of the Egyptian epagomenae, whence winter solstice fell on 6 Daθušō. This proves that a beginning of the Persian year at winter solstice is out of the question.

existed from the beginning or was introduced only after the first intercalation, as suggested by Taqizadeh).[1] But certainty can be obtained only by testing whether either of the two possible intercalation intervals, 120 or 116 years, produces confirmation of known historical facts or dates. To this end we list in Table 5 the dates in the Julian calendar corresponding to the first day of Farvardīn at the beginning of each intercalation period.

IV. 14. While nothing pertinent to our problem appears to result from the 120-year sequence, at least two of the dates found in the 116-year sequence are of great interest:

(1) *The year A.D. 425.* Bīrūnī reports (see IV. 2) that the Persians "anticipated intercalating the year by two months [*yataqaddamūna bi-kabsihā bi-šahraini*] when they expected that at the time of the next coming intercalation circumstances would distract their attention therefrom, as it has been done in the time of Yazdajird I b.Sābūr, for no other motive but that of precaution". The dual *šahrain* is doubtless an error caused by the preceding *šahrān*, which refers to *neglected* intercalations. It must of course read *bi-šahrin*, "by [one] month". But even an anticipated single intercalation will appear motivated only if political calamities (such as mentioned in the preceding passage) can be expected to disturb law and order in the near future. For nobody can foresee what will happen 30 years hence. Now the trouble arising after Yazdagird's death in or about A.D. 420 (note that he was surnamed Bazagar, "the sinner", and that his subjects had suffered greatly by his injustice)[2] could easily have been foreseen. Therefore it sounds plausible that the eighth intercalation (perhaps together with a neglected seventh) was anticipated towards the end of his reign, in view of the fact that it was due within a very short period of time, at the most a decade. For, the correct date for it results from our 116 year period: 7 August 425, within five years after the tyrant's death, caused by the well-aimed kick of a wild horse which, according to Firdausī and Ṭabarī, had been sent from Heaven, doubtless expressly for the purpose. By contrast, the 120-year period yields the date A.D. 457. For the reason mentioned – it was 37 years after Yazdagird's death – it is unthinkable that so far ahead an intercalation should have been anticipated during his reign.

[1] *Op. cit.*, p. 608.

[2] Cf. F. Spiegel, *Erânische Alterthumskunde* III (Leipzig, 1878), pp. 340–7: A. Christensen, *L'Iran sous les Sassanides* (Copenhagen, 1944), p. 269 and *CHI* III, p. 143.

(2) *The year A.D. 1005.* All later authors agree with Abu'l-Ḥasan Kūšyār's report that in the year 375 of the Yazdagird Era, "when the Sun entered Aries on the first day of Farvardīnmāh, the five days became attached to the 12th month, Esfendārmoḏmāh" (see IV. 2). Now the first Farvardīn 375 actually fell on the very day of spring equinox, 15 March (Julian), which thus had been determined with admirable accuracy. But, alas, the concordance with the 116-year period is not perfect because this latter yields for the beginning of the new period the year A.D. 1005 instead of 1006, whence one should expect the transfer of the epagomenae to have been ordered already at the end of A.Y. 373.

This difference of one year may of course be due to a simple slip. We might content ourselves with this in view of the indubitable fact that the agreement cannot be accidental, and take it as a confirmation of the Later Avestan calendar's starting point of 27 March 503 B.C., as well as of the 116-year intercalation period. However, it is even possible to account for the disturbing discrepancy of 365 days.

From Table 5 we see that in A.D. 541 a transfer of the epagomenae from their place after Ābānmāh (8) to Āḏārmāh (9) was due; thereafter, in 657, to Deimāh (10), in 773 to Bahmanmāh (11), and in 889 to Esfendārmoḏmāh (12). None of those changes we know was carried out, so it was only in 1006 that the long-overdue correction was made. With it the calendar experts wished to restore the order prevailing at the calendar's outset by appending the epagomenae to the *last month*. Correctly, however, they ought to have transferred them to next after the first month, Farvardīnmāh, of the following year. The situation in A.D. 1005 thus was similar to that in the 117th year (see Table 4, where the year numbers in brackets count), but the circumstance that the epagomenae were decreed to occupy the place they theoretically should have held in the *preceding* period, doubtless caused some confusion. The choice of A.Y. 375 may thus have resulted from a compromise between the experts' differing opinions.

Considering that Bīrūnī, as the greatest expert in chronology, mentions the 116-year period in *al-Āthār al-bāqiya*, written a few years before the crucial years 1005–6, there seems to be a high probability of his having taken part in the deliberations that led to the reform.

IV. 15. This post-Sasanian intercalation we have seen falls exactly into the span of 4 years, A.D. 1004–7, when for the first time since the Later

Avestan calendar's inception the first day of Farvardīn again coincided with spring equinox, after having travelled, retrogressively through the seasons, from 27 March (Julian) = 21 March (Gregorian) 503 B.C. to 15 March (= 21 March Gregorian) A.D. 1005. Abu'l-Ḥasan's insistence upon this fact (IV. 2) leaves no doubt that it played a decisive part in the choice of this date for the last change in the position of the epagomenae. But the fact itself that the epagomenae were transferred constitutes clear evidence that the experts were still aware of the old tradition, and that the coincidence of 1st Farvardīn with the Sun's entering the sign of Aries only was taken as confirmation of the calendar's admirably exact functioning.

What they doubtless were not aware of, however, was that the 116-year period, at the time of its invention and introduction, had been destined to connect for ever the religious (vihēčakīk) year not with the Sun's return to the equinox (the tropical year, then not yet distinguished from the sidereal), but with the annual risings and settings of stars, as shown in Table 2. When in 503 B.C. the Zoroastrian priests – or whoever was responsible – let their new calendar start on the day of spring equinox, so as to achieve a seamless transition from the Old Persian lunisolar calendar, they in all probability believed that they were replacing a well-working solar calendar with a complicated lunisolar, which just in the selfsame year was being cast into workable shape. Before long, however, it would become obvious that the spring equinox and the gāhānbārs were gradually changing their position within the new calendar. At the latest shortly after the middle of the 5th century, which will be found valid for the period of the gāhānbār dates recorded in *Āfrīnakān* 3.7–12 (see III. 14, p. 751 and V. 1–2, p. 781), measures must have been discussed to restore the year to its original state, in other words, to introduce a vihēčakīk year. Among these the 116-year period, worked out perhaps by having recourse to Babylonian astronomers, was found best fitted for the purpose; in point of fact, it was a pretty nearly ideal solution to the problem.

IV. 16. The 1,508 vague years comprised between the spring equinoxes of 503 B.C. (i.e. −502) and A.D. 1006 thus equal exactly 1507 tropical years (T). Indeed, the value resulting from the formula

$$T = \frac{1508}{1507} \times 365 = 365.24220$$

is correct to the fifth decimal place.

By contrast, the sidereal phenomena, such as the cosmical setting of

Spica, which originally had marked the time of spring equinox, inevitably underwent changes which in due course must have become perceptible, although during the first two or three intercalation periods they may have been attributed to the circumstance that observations were no longer made in Persepolis but at places having another latitude and different elevations of the apparent horizon. The difference between the sidereal year according to Bīrūnī, 365.2586 (see IV. 7) and the tropical 365.2422, is 0.0164 days. This amounts to 1 day in 61 years, to 2 days at the beginning of the first intercalation period, and to 25 days at the beginning of the 13th period (A.D. 1005). Counting with the modern value for the sidereal year (365.2564), which we have seen falls a little short of Bīrūnī's, a difference of 1 day is reached only after *c.* 70 years (the effect of precession), which amounts to *c.* 21 (instead of 25) days in 1,500 years.

Checking now with astronomical facts, we find that the cosmical setting of Spica in about A.D. 1000, fell on *c.* 11 April, that is to say, not 21 but 27 days after the equinox, on 27 Farvardīn. The discrepancy of 6 days is explained by the fact (not to be discussed here) that the annual phases of stars do not repeat themselves at intervals identical with the sidereal year. In the case of Spica the interval is shorter. It amounts to 1 day in *c.* 56 years (as against the 70 years corresponding to the motion of precession).

The calendar reformers of A.Y. 375 could not possibly be aware of this displacement since in all probability the astronomical situation obtaining when the calendar was started had never been officially recorded. What they knew, witness Bīrūnī's report, was that the first year had begun with the day of spring equinox. They were content to find that this was again the case when according to the 116-year cycle a new intercalation had become due.

THE JALĀLĪ CALENDAR

IV. 17. The vague year combined with the Yazdagird Era remained in use until fairly recent times, unaffected by the reform decreed in the 7th year of the Saljuq Sulṭān Jalāl al-Dīn Malikšāh (1073–92), about which a few words have to be said in this context.

At the order of Malikšāh a group of eight mathematicians and astronomers, among them the great 'Umar Khayyām, had worked out a calendar destined to remain connected for ever with the tropical year.

It thus marked a definitive break with the Later Avestan calendar. The epoch of this *Tārīkh-i Jalālī* was chosen to be 19 Farvardīnmāh A.Y. 448 = 15 March A.D. 1079 because on that day, according to Šāh Kholjī, the Sun entered Aries about the time of sunrise. This is borne out by modern computation: at the Saljuq Sultan's residence, Isfahān, the Sun actually reached the vernal point at *c.* $6^{h}20^{m}$ a.m. (mean time), in other words, 20 minutes after sunrise. Thus in 1079, 19 Farvardīn "old style" (*qadīm*) became 1 Farvardīn "new style" (Jalālī), and this first day of the year was thenceforth called *Naurōz-i-Sulṭānī*. The names of the months were the same as in the vague year, with the epagomenae attached to Esfendārmoḏmāh. In cases in which confusion between the two calendars could arise, the words qadīm and Jalālī (or Sulṭānī), respectively, were added. The concordance with the tropical year was warranted by making years of 365 days (with 5 epagomenae) alternate in an appropriate order with years of 366 days (6 epagomenae). The system of intercalation was complicated: 8 intercalary days in 33 years alternated with 9 in 37 and 7 in 29, but in view of the fact that we ignore the exact sequence of those subcycles, conversions of Jalālī into Julian dates always involve the possibility of an error of one day. According to Ulugh Beg the mean length of the Jalālī year was 365;14,33,7,32 days (sexagesimal fractions) = 365.242535 days. The accuracy of this value – exceeding the length of the Gregorian year by only 3 seconds, and that of the true tropical year by 29 seconds – is admirable. As Ginzel[1] has shown, it can be approximated by the fraction $365\frac{65}{268} = 365.242537$ (0.6 seconds too high), from which it results that 65 years out of 268 must be leap-years of 366 days. This can be achieved by combining 7 subcycles of 33 years (having $7 \times 8 = 56$ intercalary days) with one subcycle of 37 years (containing 9 intercalary days).

The calendar of the French Revolution, apart from the year's beginning at autumn equinox, is practically identical with the Jalālī, thereby betokening the paternity of the latter.

[1] *Handbuch* I, pp. 301ff.; from the fixation of 1st Farvardīnmāh (Jalālī), year no. 1, on the day on which the Sun entered Aries shortly after sunrise it is seen that the days were counted from sunrise. This is confirmed by *Bundahišn* Ch. 25 (ed. Anklesaria, 157, Justi, 59; cf. Nyberg, *Texte*, pp. 10/11): "Always the day is to be counted first and then the ensuing night." Considering the tenacity of such traditions, it is very probable that this was the case also in earlier, perhaps already Achaemenian times.

THE DAYS OF THE MONTH

IV. 18. Unlike most other calendars, except the Old-Egyptian,[1] the days of the Later Avestan months were not numbered but had special religious names (see Table 6). "Divinities honoured by the names", says Ilya Gershevitch,[2] "include Ahura Mazdāh,[3] six 'Holy Immortals' (i.e., Amәša Spәntas), Mithra, Anāhitā,[3] Tištrya, Fire, the Fravašis,[4] Sun, Moon, Sky, Earth, Wind, the Soul of the Cow, the Religion, Discipline, Reward, in short, most of the deities of the Zarathuštric religion, with the notable exception of Haoma." This characteristic feature: Haoma's name lacking among the calendar names, supported by Herodotus I. 132, where no Haoma libation is mentioned in the description of the Persian sacrifices, clearly shows that the calendar names could not have been selected by Zarathuštric priests because they "would scarcely have failed to include the patron-god of their own class, whom they regarded as the divine priest of Ahura Mazdāh (Yašt 10.89f.) to whom Ahura Mazdāh himself had entrusted the Mazdayasnian religion (Yasna 9.26)".[5] Gershevitch therefore suggests that the calendar in its definitive shape ought to be termed Magian rather than Zoroastrian, basing himself on the fact that its names are "a selective index of the Magian repertory". A borrowing from Egypt, unlikely in itself, therefore seems out of the question. On the other hand, "the day-names may well belong to a later period of systematization, but it is worth stating that that period must still have been the *Old* Iranian, i.e. the Achaemenian. This is shown by the *form* of some of the names in Middle Iranian, in instances where that form is explicable only as the outcome of an *Old* Iranian genitive (governed by an implied word for 'day'). For instance, 'bull' is *gāv* in Middle Persian and New Persian, from the Old Iranian nominative *gāuš* or accusative *gāvam*, both with long *ā*; while the

[1] In the Egyptian calendar special denominations for the 30 days of the *lunar* calendar occur; see H. Bruggsch, *Thesaurus inscriptionum Aegypticarum* (Leipzig, 1883–91), pp. 46–8, and R. A. Parker, *The Calendars of Ancient Egypt* (Chicago, 1950), §36, pp. 11f.

[2] "Zoroaster's Own Contribution", *JNES* XXIII (1964), pp. 12–38; see p. 21. Gershevitch distinguishes between *Zarathuštrianism* = religion of the Gathas, and *Zarathuštricism* = doctrine of the Later Avestan texts, reserving *Zoroastrianism* for the doctrine's later form during the Sasanian period.

[3] "Ahura Mazdāh and Anāhitā are not referred to in the calendar by these names, but respectively as *Daθušō*, lit. 'the Creator', and *Apąm*, lit. 'the Waters' (of which Anāhitā was the goddess)", *ibid.*, n. 34.

[4] "These twelve divinities account for the names of the months, but they also occur as lay-names," *ibid.*, n. 35.

[5] *Ibid.*, p. 26 and n. 43.

exclusively calendrical *gōš* can only represent the Old Iranian genitive *gauš*, with short *ă*. The systematization may have been the work of the Magi, and the replacement of Tištrya with Tīr in Persis may have occurred on the occasion of it."[1]

For the inception of the new way of denoting the days of the months by the names of Magian divinities instead of simply numbering them from 1 to 30, Gershevitch accepts the year 441 B.C. proposed by Taqizadeh as the beginning, or at least a year near the beginning, of the vihēčakīk year.[2] As will be shown (V. 2) the year can be narrowed down to the period 447–444 B.C. But the assertion that this marked the start of the vihēčakīk year cannot be maintained because it is incompatible with the pertinent mathematical demonstration given in IV. 12–16. It is possible, even probable, that this new determination and fixation of the gāhānbārs, carried out then, but preceded *c.* 15 years earlier by one of the equinoxes (see V. 3) was the last stimulus to considerations culminating in the establishment of the 116-year cycle, but it will have been put in practice only by the first intercalation in 387 B.C. Hence the term "reform", as used by Gershevitch,[3] is justified only if limited to the change from day numbers to day divinities hailing from the Magian pantheon, which in all probability was facilitated by Artaxerxes I's permissiveness.

It seems out of the question that those day names could ever replace

[1] Personal communication by I. Gershevitch (letter of 12 April, 1974). [The Middle Parthian equivalent *gwyrh* of Middle Persian *gōš* (whose *š* can owe its presence only to learned tradition, as itself vouchsafes Achaemenian origin of the calendar name) will likewise be of Old Iranian coinage if it represents a compound containing *ayar-*, a word for "day" extinct by the Middle period of Parthian; see *Studia classica et orientalia A. Pagliaro oblata* II (Rome, 1969), p. 197. Other calendar names whose Middle Iranian forms presuppose Old Iranian genitives are Pahlavī *šahrēvar* (*-ē-* from Old Iranian *-ahe*, itself from *-ahya*), *fravardīn*, and *anagrān* (from Old Persian **anagrānām*), quite likely also short-vowelled *abān* (from *apām*, with *-m* preserved like the *-š* of *gauš* until *-n* took over so as to "regularize" what it became tempting to consider the plural of Middle Persian *āb*). The Middle Sogdian calendar names (see W. B. Henning, *Orientalia* VIII (1939), 94f.) in addition to *xšēwar*, *γoš* and *naγran* include four others of genitival coinage: nos 8 and 15 *δəščī* and no. 9 *āš* (see Henning, p. 91, nn. 1 and 2), as well as no. 2 *xumna* and no. 20 *wšaγna* (see *GMS*, §404); a fifth is perhaps no. 28 *ẓmuxtuγ* (if its *γ* represents, with voice-dissimilation, the second *h* of Avestan *ẓəmō huδåŋhō*; cf. Pahlavī *ẓamyād*, which looks like a re-interpretation as **ẓama(h-h)udāt* "well-created earth", of the original intermediary **ẓam(ah-h)udāh* "beneficial earth"). As indicated by reference to Marquart and Henning in *Mémorial Jean de Menasce* (Louvain, 1974), p. 71, apart from formal considerations Old Iranian origin of the so-called "Zoroastrian" calendar terms is guaranteed by their geographical spread from Cappadocia to Chorasmia, an enormous area never again to find itself, after the fall of the Achaemenian empire, under one single political sway that could have imposed on it a uniform terminology. (*GMS* = Gershevitch, *A grammar of Manichaean Sogdian*, Oxford, 1954; repr. 1961.) Ed.]

[2] *Op. cit.*, p. 603: "The date I propose was 441 B.C., or at any rate some time in the first decade of the second half of the 5th century B.C."

[3] "Zoroaster's own contribution", p. 21.

in popular usage the original day numbers; even in our days one would not expect common man to memorize a sequence of 30 deities for use in ordinary life. This practice was evidently limited to the clergy and to learned circles.

In Table 6 the day names are given in their Avestan, Pahlavī and New Persian forms (the latter according to Bīrūnī). The name of the highest god, Ahura Mazdāh occupies the first place; it is then repeated three times under the denomination Daθušō, "Creator": nos. 8, 15, 23. In Pahlavī, to avoid confusion, the three different Daθušō = Dai are distinguished by adding the name of the next divinity: *Dai-pad-Ādur*, "the Dai(-day) at Ādur(-day)" (see p. 748, n. 1) etc. Thus the Creator's name divides the month into periods of $2 \times 7 + 2 \times 8$ days. On the other hand, Ahura Mazdāh (no. 1) and Miθra (no. 16) each head one of the month's two halves, while in the month names, Daθušō occupies the 10th place and Miθra the 6th. The complete sequence of correspondences between month-names and day-names is shown below:

Avestan name	Month no.	Day no.
Fravašinąm	1	19
Ašahe vahištahe	2	3
Haurvatātō	3	6
Tištryehe	4	13
Amərətātō	5	7
Xšaθrahe vairyehe	6	4
Miθrahe	7	16
Apąm	8	10
Āθrō	9	9
Daθušō	10	1, 8, 15, 23
Vaŋhave manaŋhe	11	2
Spəntayå ārmatōiš	12	5

IV. 19. As will be discussed in detail, the coincidences between month and day names were duly celebrated by festivals. Among them, two seem of special interest because they may reflect, as pointed out by Taqizadeh,[1] the astronomical situation at the time of the introduction of the Magian day-names, i.e. the alleged "reform" of 441 B.C. Taqizadeh's assumption that the Mihragān (Miθrakāna), which was the most important festival after Naurōz, at the time of its introduction fell on autumn equinox, and Tīragān (which in Avestan would have been *Tištryakāna) on

[1] *Op. cit.*, p. 607.

summer solstice, sounds plausible; but the astronomical and calendrical data by which he tries to confirm the date 441 are not correct. Postulating that the autumnal equinox was observed with the same degree of accuracy as the vernal, while summer solstice, in accordance with III. 16, *c.* two days too early, we find that the conditions: 16 Mehr = 21 September (Gregorian) = 26 September (Julian) = autumn equinox, and 13 Tīr = 19 June (Gregorian) = 24 June (Julian) = 2 days before summer solstice, are fulfilled for the period of 4 years, 457–454 B.C. This period comes close by 7 to 10 years to the period 447–444 mentioned above, which has to be substituted for Taqizadeh's 441 B.C. Since the period 447–444 results (V. 2) from the changed position of the solar dates (the gāhānbārs) within the vague year, the difference of 7 to 10 years, corresponding to 2 days in the calendar date, must be ascribed to observational errors. In view of the circumstance, however, that the gāhānbār dating is better founded than that by the summer and autumn festivals, preference has to be given to the former.

THE FIVE EPAGOMENAL DAYS

IV. 20. The 5 epagomenal days ("Gāθā days") are called after the 5 Gāθās: Ahunavaitī, Uštavaitī, Spəntāmainyu, Vohuxšaθrā and Vahištōištī. However, there must have existed a great many different denominations, witness Bīrūnī,[1] who cites no less than six widely different traditions, with the remark that he never read them in two books or heard them from two men alike.[2] According to the *Dēnkart*, Book VIII,[3] the five Gāθā days are "dedicated to all of the gods".

DIVISIONS OF THE DAY

IV. 21. Divisions of the day are mentioned in *Bundahišn* 25:[4] "During the 7 summer months (Fravardīn through Mihr) the canonical times of the days and nights are five because they invoke the Rapiθvin. At dawn one had the Hāvan time, at noon, the Rapiθvin, at sunset, the

[1] "Chronology", Ar. text, pp. 43f., transl., pp. 53f.

[2] According to Bīrūnī, Zādawayhi b. Šāhawayhi, in his book on the causes of the festivals of the Persians, has all five of the *Gāθā* names preceded by the word fanjah. This evidently renders the Pahlavī term *panjak*, "pentad", found in *Dēnkart* III and elsewhere.

[3] Ed. Madan, pp. 683f., cited after Nyberg, *Texte*, pp. 8/9.

[4] Nyberg, *Texte*, pp. 12/13.

Uzayarin; from the time the stars come to appearance till midnight, one has the Aibisrūθrin time, and for midnight till their disappearance, the Ušahin time. In winter there are only four such times, for the period from the morning up to the Uzayarin is then called Hāvan time, and the rest is as I have said." The corresponding Avestan names are given in Yasna I. 3–7: Hāvani, Rapiθwina, Uzayeirina, Aiwisrūθrima aibigaya, and Ušahina. Obviously the Pahlavī text has preserved here the old Avestan forms.

DAY PENTADS: RELICS OF A RELIGIOUS LUNAR YEAR

IV. 22. The 3rd Book of the *Dēnkart*[1] contains a passage apparently attesting that the lunar year had not disappeared completely from the Zoroastrian religion, though nothing seems to be known as to when and where such a year could have been in use side by side with the well-established vague year (called in *Dēnkart* "*ōšmurtīk*", i.e. "computational" year, also *rōč-vihēčakīk*, which Nyberg (p. 84) renders with *Tagesschaltjahr*, "day-intercalation-year" although the 5 epagomenal days have of course nothing to do with intercalation) or the fixed solar (vihēčakīk, "intercalary") year.

Each *lunar* month, it says, according to its religious division has 5 pentads (*panjak*),[2] three of which carry (individual) names. One of them is called Andarmāh;[3] its first day is the first, and its last day the 5th after neomenia. Another pentad is Purrmāh[4] (11th–15th day), a third is Višaptas[5] (21st–25th day). "These three pentads are called the holy panjaks."

Of the second series of pentads, one is called Counter (*patīrak*)-Andarmāh (6th–10th day), another Counter-Purrmāh (16th–20th day), a third one Counter-Višaptas (26th–30th day), "whose last day is the 30th day after the same neomenia. The activity at the next neomenia continues immediately the three periods and the ones depending on them" (i.e. the chief and counter-panjaks).

[1] Ed. Madan, pp. 274–6; cited after Nyberg, *Texte*, pp. 40/41–42/43.

[2] See p. 777, n. 2. Nyberg renders *panjak* with "Fünfwoche".

[3] Avestan *antarəmāh*, "divinity of the New Moon", see C. Bartholomae, *Altiranisches Wörterbuch* (Strassburg, 1904), column 134. In Bīrūnī's list of festivals (see IV. 23) the epagomenae are called *āndārmāh*.

[4] Av. *pərənō.māh*, "divinity of the Full Moon", Bartholomae, col. 895.

[5] Transliteration of Av. *vīšaptaθa*, "divinity of the seventh day inserted after each neomenia and plenilune", Bartholomae, col. 1472. The meaning of this explanation seems veiled.

Needless to say such a system is applicable only to months of 30 days, in other words, to the vague year, not to the lunar month with the mean length of $29\frac{1}{2}$ days. But the text is clear enough to exclude the possibility of a trivial misunderstanding. In the absence of further evidence this strange passage must remain unexplained.

RELIGIOUS FESTIVALS AND GĀHĀNBĀRS

IV. 23. The Persian festivals are described and explained at length by Bīrūnī, in his "Chronology"[1] as well as in the "Mas'ūdic Canon".[2] The 6 gāhānbārs, originally, as demonstrated in III. 13, essentially different from the Zoroastrian religious festivals, are mentioned indiscriminately with the latter by Bīrūnī. At his time their purely astronomical character had probably long since fallen into oblivion, and no mention is made of their original meaning. It has to be noted here again that the gāhānbārs as well as other festivals stretched over a period of 5 days (see end of IV. 5), the last of which was considered most important. According to the "Mas'ūdic Canon", the festivals are the following:

1st Farvardīn: *Naurūz al-Malik* (New Year's Day)
6th Farvardīn: The Great Naurūz, also called "The Proper Naurūz" (*Naurūz al-khāṣṣa*)
16th Farvardīn: Beginning of *al-Zamzama* ("the whispering")
19th Farvardīn: *Farvardīgān (celebrated on the day Farvardīn)[3]
3rd Ordībehešt: *Ardēbeheštagān
26th Ordībehešt: 1st day of 3rd gāhānbār (Paitiš.hahya)[4]
30th Ordībehešt: Last day of 3rd gāhānbār
6th Khordād: *Khordādagān
26th Khordād: 1st day of 4th gāhānbār (Ayāθrīma)
30th Khordād: Last day of 4th gāhānbār
6th Tīr: Čašn-i-nīlūfar (cited only in *al-Āthār al-bāqiya*)
15th Tīr: *Tīragān, Feast of Ceremonial Ablution
7th Mordād: *Mordādagān

[1] Ch. IX, pp. 215–33; transl., pp. 199–219.

[2] *al-Qānūn al-Mas'ūdī* I (Hyderabad, Deccan, 1373/1954), *Maq.* 2, Ch. 11, pp. 258–66; list on pp. 259f.

[3] The Feasts of the Months, Farvardīgān, Ardēbeheštagān, etc. (marked in the above list by an asterisk) are celebrated on the day carrying the same name as the month, see IV. 19. Cf. the corresponding celebration of festivals in the Chinese calendar: 3rd month, 3rd day, Feast of the Dead (Graves); 5th of 5th month, Feast of the Dragon Boats, etc.

[4] Bīrūnī mentions the names of the gāhānbārs only in his "Chronology"; in the "Mas'ūdic Canon" the numbers ("1st gānānbār", etc.) alone are given.

4th Šahrīvar: *Šahrīvaragān, called *ādar-jušn*, "Feast of the Fire"
16th Šahrīvar: 1st day of 5th gāhānbār (Maiδyāirya)
20th Šahrīvar: Last day of 5th gāhānbār
16th Mehr: *Mihrajān
20th Mehr: *Rām-rūz* ("the mild day"), i.e. the Great Mihrajān
10th Ābān: *Ābānagān
26th Ābān: 1st day of Farvardījān
1st Andarmāh: 1st day of 6th gāhānbār (Hamaspaθmaēdaya) (Epagomenae)
5th Andarmāh: Last day of Farvardījān and of 6th gāhānbār
1st Ādār: *Bihār-čašn*, "Feast of Spring" ("this means *rukūb al-kūsaj*, the mounting of the youth")
9th Ādār: **Ādār-čašn*
1st Dei: *Feast of *Khurra-rūz* (*Khuram*?), also called *Nawad-rūz*[1]
8th Dei: *First Feast of Dei
11th Dei: 1st day of 1st gāhānbār (Maiδyōizarəmaya)
14th Dei: *Sīr-sawā*[2]
15th Dei: *Second Feast of Dei and last day of 1st gāhānbār
15th Dei: *Bantīgān* (?)
17th Dei: Night of *Gāv-i-kīl* (?)
23rd Dei: *Third Feast of Dei
2nd Bahmen: **Bahmenagān*
5th Bahmen: *Barsadaq*[3]
10th Bahmen: Night of *al-Sadaq*
30th Bahmen: *Āfrījagān*[4] (with the remark "at Isfahan")
5th Esfendārmod: **Katbat riqā' al-'aqārib*[5]
11th Esfendārmod: 1st day of 2nd gāhānbār (Maiδyōišam)
15th Esfendārmod: Last day of 2nd gāhānbār

THE FESTIVALS OF FARVARDĪJĀN AND OF THE KATBAT RIQĀ' AL-'AQĀRIB

IV. 24. In the "Mas'ūdic Canon" (p. 264), Bīrūnī attributes special importance to the Farvardījān, being one of the most highly esteemed festivals. Since the passage in question illustrates the difficulties arising from the transfer of the epagomenae, I give it here *in extenso.*

The Farvardījān is the period of 5 days in which food and drink is offered to the spirits of their dead because these 5 days were destined to spiritual exercise.

[1] Probably *Navad-rūz*, "Ninety days", because it precedes the *Naurōz* by 90 days.
[2] Perhaps *sair-i sawā'*, "equal course".
[3] Perhaps *pur-sadaf*, "plenty of darkness".
[4] The "Mas'ūdic Canon" has *āb-rīz-gān*.
[5] "Inscribing of pieces of paper with scorpions"; in "Chronology", p. 229 (transl., p. 216), Bīrūnī says that on this day magic charms against the bite of scorpions are accomplished by such inscriptions.

They fall into the last part of Ābānmāh. However, when by the eighth intercalation after Zarādušt the epagomenae (here called mustaraqa, as against Andarmāh in the above list) were transferred to the end of Ābānmāh, where they remained ever since, to the effect that they were counted together, opinions differed as to whether the Farvardījān or the 5 epagomenae should be the last 5 days of Ābānmāh, which was of importance to their religion. Therefore for the sake of safety they took both together and made the Farvardījān a festival of ten days.

According to the "Mas'ūdic Canon" (p. 266), the fifth day of Esfendārmodmāh, in past days the feast of women, "is now known by the name *katbat al-riqā'*, 'inscribing pieces of paper', because the common people write on that day charms which they fasten to the walls of their houses to avert the damage of insects, in particular of scorpions". In the "Chronology" (p. 229, transl. 216) it is said moreover that this is done "in the time between dawnrise and sunrise". This very probably refers to the heliacal rising of α Scorpii (Antares). The time when the heliacal rising of Antares occurred in the first days of Esfendārmodmāh results from a rough computation as *c.* 100 B.C.

PART V. THE CHRONOLOGY OF THE LATER AVESTAN CALENDAR

V. 1. In III. 13–19 we have shown that the differences in days between the 6 gāhānbārs as reported concordantly in *Āfrīnakān* 3.7–12 and in Bīrūnī's "Chronology" permit us to conclude that these gāhānbārs, among which figure the winter and summer solstices, were determined by the apparent acronychal risings and cosmical settings of a small number of bright stars observed from the Persepolis plateau during the later part of the 6th century B.C. Since the cosmical settings, contrary to acronychal risings, are referred to the level western horizon, their validity is not restricted to Persepolis and stretches over several centuries on account of the relatively slow motion of precession. They had to be regarded as indicators of solar dates even after Persepolis had ceased to be the capital of the Iranian Empire.

Numbering, as in Tables 2 and 3, the gāhānbārs from I (Maiδyōi-zarəmaya) to VI (Hamaspaθmaēdaya) and adding to them *N* (Naurōz), we thus have the correspondences valid for the year of inception, 503 B.C., as shown in the accompanying table.

Gāhānbār	Date Gregorian	Julian	Date Later Avestan	Days elapsed	Apparent cosmical setting of
N	21 March	27	1 Farvardīn		α Virginis, Spica (*ab . sin*)
I	20 April	26	1 Ordībehešt	45 since VI	α Librae (*zi . ba . ni . tum*)
II	19 June	25	1 Tīr	60 since I	ρ Sagittarii (PA . BIL . SAG, last star)
III	2 Sept.	8	16 Šahrīvar	75 since II	β Pegasi (IKU, main star)
IV	2 Oct.	8	16 Mehr	30 since III	α Trianguli (APIN) + α Arietis (*ḫun . gá*)
V	21 Dec.	27	6 Dei	80 since IV	α + β Geminorum, Castor + Pollux (*maš . tab . ba . gal . gal*)
VI	6 March	12	21 Esfendārmoḏ	75 since V	β Leonis, Denebola (*ur . gu . la*, last star)

V. 2. These original dates, valid for the first four years of the new calendar (503–500 B.C.) have to be compared with those recorded in *Āfrīnakān*[1] and in Bīrūnī, as shown in the accompanying list, where in col. *D* also the positions of the gāhānbārs in the Khwārizmian year are added according to Bīrūnī.[2]

Gāhānbār	*A* Date, 503 B.C.	*B* Date (Āfrīnakān)	*C* Date (Bīrūnī)	*D* Khwārizmian Date
I	1 Ordībehešt (2nd month)	15 Ordībehešt	15 Dei (10th month)	15 5th month
II	1 Tīr (4th month)	15 Tīr	15 Esfendār. (12th month)	15 7th month
III	16 Šahrīvar (6th month)	30 Šahrīvar	30 Ordībehešt (2nd month)	1 10th month
IV	16 Mehr (7th month)	30 Mehr	30 Khordād (3rd month)	1 11th month
V	6 Dei (10th month)	20 Dei	20 Šahrīvar (6th month)	11 1st month
VI	21 Esfendārmoḏ (12th month)	5th epag. day (after Esfend.)	5th epag. day (after Ābān)	1 4th month

From the trivial fact that the *Āfrīnakān* dates, *B*, have advanced by 14 days from their original position, *A*, it results that they represent the situation obtaining 4.14 = 56 years, or nearly exactly one-half inter-

[1] Even though the *Āfrīnakān* text, such as we have it today, may originate from a later period, the dates recorded must be regarded as genuine; cf. p. 751, n. 1.

[2] "Chronology", pp. 237f. (transl. 225); cf. Taqizadeh, *op. cit.*, p. 609.

calation period, after the initial 4 year period, i.e. during the years 447–444 B.C. (cf. IV. 18–19).[1]

The *Āfrīnakān* dates remained stable in the vihēčakīk year throughout the centuries, as long as it continued functioning. In the vague year they advanced by one month with every new intercalation, but actually represented the original astronomical situation only in the middle of each period (331, 215, 99 B.C., and A.D. 18, 134, 250, 366, 480). After the eighth intercalation, due in A.D. 425 and carried out some years before (see IV. 13–14), they thus fell 8 months later, occupying then the places recorded by Bīrūnī (see col. *C*). By that time, however, the difference between the length of the tropical year and that of the sidereal (with which corresponds the 116-year period) had caused perceptible changes, to the effect that V (Maiδyāirya) in A.D. 480 fell 15 days after winter solstice, on 4 January.[2]

V. 3. Dates for the two chief gāhānbārs: summer and winter solstice, were also given in *Bundahišn*, Ch. 25:

From the Maiδyōišam Festival, which falls on the day Xvar (no. 11) of the month Tīr in the vihēčakīk year, till the Maiδyāiri Festival, which falls on the day Varhrān (no. 20) of the month Daδv in the vihēčakīk year, the length of the day diminishes and that of the night increases; and from Maiδyāiri to Maiδyōišam the night diminishes and the day increases.[3]

Here the date of winter solstice, 20 Dei, is the same as in *Āfrīnakān*, while that for summer solstice, 11 Tīr (which incidentally precedes by 2 days the Tīragān Festival on 13 Tīr, see IV. 19), 4 days earlier than the expected 15 Tīr, would be valid for the period 463–460 B.C. Considering that the day-name Xvar (11) can hardly have been confused by a copyist with Dei-i-pad Mihr (day no. 15), the possibility must be envisaged that the date 11 Tīr reflects an observation of the summer

[1] For earlier attempts to establish the probable epoch of the Later Avestan calendar, I refer to J. Marquart, *Untersuchungen zur Geschichte von Eran* II (Leipzig, 1905); J. Markwart (identical with the preceding!), "Das Nauroz, seine Geschichte und seine Bedeutung", in *Dr. Modi Memorial Volume* (Bombay, 1930), pp. 709–765B, and S. H. Taqizadeh's important work *Gāh-šumārī dar Īrān-i qadīm* (Tehran, 1315/1938). Taqizadeh revised his theories propounded there in his *Old Iranian Calendars* (London, 1938, Royal Asiatic Society Prize Publication Fund 16) and again in his "The Old Iranian Calendars Again".

[2] In the 4th and 5th centuries the Gregorian calendar was one day ahead of the Julian.

[3] After Nyberg, *Texte*, pp. 10/11. In the ensuing passage it is said that the longest summer day equals in length two winter days, and the longest winter night, two summer nights. This would correspond approximately to the northern latitude of 49° (Paris or the region north of the Caspian Sea).

solstice made 16 years before the *Āfrīnakān* dates were recorded. The question would have to be left open were it not for the Khwārizmian dates recorded by Bīrūnī (see col. *D* in the above list).

The first two of these Khwārizmian gāhānbārs lie exactly 3 months, or 90 days, later than the *Āfrīnakān* dates, while III, IV and VI evidence a slight deviation: 91 days, which was probably caused by the wish to make the gāhānbārs fall on the first day of the respective months instead of the last day of the preceding. So far everything seems clear: the Khwārizmian vihēčakīk calendar was discontinued after the third intercalation, and the Bīrūnian dates render the situation obtaining about the middle of the third period, i.e. *c.* 100 B.C. (see V. 2).

However, a remarkable exception is formed by V, winter solstice. It falls not 90 or 91, but only 86 days after the *Āfrīnakān* date, on the 11th day of the first month. This means that the original position of Khwārizmian V was 16 Dei, 4 days before the *Āfrīnakān*, 20 Dei, in perfect accordance with the *Bundahišn* date, 11 Tīr, for summer solstice. The conclusion to be drawn, inevitably, is that 16 years before the *Āfrīnakān* observations of all the 6 gāhānbārs, the two chief gāhānbārs, i.e. the solstices, were observed isolatedly about the years 463–460, in other words, during the first years of Artaxerxes I (464–424 B.C.) and that one of the dates then found has survived in the *Bundahišn*, the other in the Khwārizmian calendar.

V. 4. Finally, an important observation which we owe to Taqizadeh has to be discussed.[1] According to him the Jalālī year (see IV. 17) beginning with the month Farvardīn at spring equinox is still in use in the rural parts and many districts of Iran, such as Kāšān, Naṭanz, Maima, Javšagān and in the province of Yazd, and continues being called by this name. At all those places the epagomenae (5 or, in leap-years, 6 days) follow after the 12th month, Esfendārmoḏ. Strangely enough, however, in many villages of the district Naṭanz, such as Abiyāneh, Barz, Chimeh, Henjan, and several others, the epagomenae are added to the 11th month, Bahman.[2]

Despite Taqizadeh's hesitancy to take this for a trace of intercalations carried out unofficially in certain parts of Iran, I see no reason to doubt that the Later Avestan calendar in this exceptional case was kept functioning until the 11th intercalation, due in A.D. 773 (see Table 5);

[1] See "The Old Iranian Calendars again" p. 610.

[2] Communicated to Taqizadeh by Professor A. K. S. Lambton.

but it will hardly be possible to find a plausible motive for the fact that with this it came to an end, as had been the case with the official calendar 350 years earlier. At any rate, it is a strong support to my claim that the tradition of the Later Avestan calendar was kept alive longer than historians so far have been inclined to believe.

TABLE 1. *The Babylonian, Elamite and Old Persian Calendars, 503–499* B.C.

Month No.	[o]	1	2	3	4	5	6	7	8	9	10	11	12	13
Darius y.19 = 503 B.C.		27 March	25 April	25 May	23 June	23 July	21 Aug.	20 Sept.	19 Oct.	18 Nov.	17 Dec.	(502) 15 Jan.	14 Feb.	16 March
Ideal scheme		I	II	III	IV	V	VI	VIa	VII	VIII	IX	X	XI	XII
Bayblonian		I	II	III	IV	V	VI	VIa	VII	VIII	IX	X	XI	XII
Old Persian		I	II	III	IV	V	VI	VII	VIII	IX	Xa	X	XI	XII
Darius y.20 = 502 B.C.		14 April	14 May	13 June	12 July	11 Aug.	9 Sept.	9 Oct.	7 Nov.	6 Dec.	(501) 5 Jan.	3 Feb.	4 March	
Ideal scheme = Babylonian		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Darius y.21 = 501 B.C.		2 April	2 May	1 June	30 June	30 July	29 Aug.	27 Sept.	27 Oct.	25 Nov.	27 Dec.	(500) 23 Jan.	21 Feb.	23 March
Ideal scheme		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIIa
Babylonian		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Darius y.22 = 500 B.C.	[23 March]	21 April	21 May	19 June	19 July	18 Aug.	17 Sept.	16 Oct.	15 Nov.	14 Dec.	(499) 12 Jan.	11 Feb.	12 March	
Ideal scheme		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Babylonian = Elamite	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIIa	
Old Persian	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
Darius y.23 = 499 B.C.	[12 March]	11 April	10 May	9 June	8 July	7 Aug.	6 Sept.	5 Oct.	4 Nov.	3 Dec.	(498) 2 Jan.	31 Jan.	2 March	
Ideal scheme = Babylonian		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
Old Persian	Ia	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	

TABLE 2. *Annual Risings and Settings of Stars Marking Naurōz and the Six Gāhānbārs, 530* B.C.

(Star names and dates in square brackets indicate phenomena preceding or following day of *Gāhānbār*)
HR = Heliacal Rising; AR = Acronychal Rising (above horizon with average elevation of 12°). HS = Heliacal Setting; CS = Cosmical Setting (below level horizon). *N* = Naurōz.

Gāhānbār	HR	AR	HS	CS
N: 21 March (Gregorian Style)	γ Andromedae (Alamak) (APIN, northernmost star)		γ Andromedae (APIN, northern part) α, β Trianguli (APIN, southern part) β Cassiopeiae (*lu . lim*) + α Ceti [η Tauri (Pleiades) (*mul* = *zappu*, 28 March]	α Virginis (Spica) (*ab . sin*)
I: 20 April		α Scorpii (Antares) *gab . gír . tab*	γ Orionis (Bellatrix) (*síb . zi . an . na*) [α Tauri (Aldebaran) (*is . li . e*) 16 April]	α Librae (*zi . ba . ni . tum*)
II: 19 June	[α Geminorum (Castor) (*maš . tab . ba . gal . gal*) 21 June]	α Sagittarii (Alrami) (PA . BIL . SAG) α, β Capricorni (Gedi) (*suḫur . maš*)	[α Hydrae (Alphard) (main star of *muš*) 14 June]	ρ Sagittarii (last star of PA . BIL . SAG) [α Ophiuchi, 23 June (Ra's al-Ḥayya)
III: 2 Sept.	[β Leonis (Denebola) (last star of *ur . gu . la*) 30 August]	αβ Trianguli (APIN south) [α, β Arietis 7 Sept. (*ḫun . ga*)]		β Pegasi (Scheat) (IKU, main star)
IV: 2 Oct.	α Bootis (Arcturus) (*šu . pa*) [α Virginis (Spica) (*ab . sin*) 30 Sept.]	η Tauri (Pleiades) *mul* = *zappu*	β (Akrab) α (Antares) + ν Scorpii (main stars of *gír . tab*)	α Trianguli (APIN) α Arietis (*ḫun-gá*)
V: 21 Dec.	α Aquilae (Altair) (našru) ρ Sagittarii (last star of PA . BIL . SAG)	α Canis minoris (Procyon) (*al . lu*) [α Canis maioris (Sirius) (gag . si . sá) 26 December]	[α Aquilae (Altair) (našru) 25 December]	α, β Geminorum (Castor & Pollux) (maš . tab . ba . gal . gal) [β Cancri, 24 Dec.]
VI: 6 March	γ Pegasi (last star of IKU)	α Virginis (Spica) (*ab . sin*) α Bootis (Arcturus) (*šu . pa*)	α Trianguli (APIN south) α Arietis (*ḫun . gá*)	β Leonis (Denebola) (last star of *ur . gu . la*)

TABLE 3. *Annual Risings and Settings (Stars listed according to increasing longitudes)*

Star or Constellation Name		Phase announcing *Naurōz* (*N*) and *Gāhānbārs* (I–VI)			
		Rising		Setting	
Akkadian	Modern	Heliacal	Acronychal	Heliacal	Cosmical
1. APIN south	α, β Trianguli	—	III	(only α) VI	IV
2. APIN north	γ Andromedae	*N*	—	with α, β Trianguli *N*	—
3. ḫun . gá	α Arietis	—	—	VI	IV
4. mul = zappu	η Tauri (Pleiades)	—	IV	7 days after *N*	
5. is . li . e	α Tauri (Aldebaran)	—	—	4 days before I	—
6. síb . zi . an . na	γ Orionis (Bellatrix)	—	—	I	—
7. maš . tab . ba . gal . gal	α Geminorum (Castor)	2 days after II	—	—	with β Geminorum (Pollux) V
8. gag . si . sá	α Canis maioris (Sirius)	—	5 days after V	—	—
9. al . lu	α Canis minoris (Procyon)	—	V	—	—
10. muš = ṣîru	β Cancri	—	—	—	3 days after V
11. main star of muš = ṣîru	α Hydrae (Alphard)	—	—	5 days before II	—
12. last star of ur . gu . la	β Leonis (Denebola)	3 days before III	—	—	VI

13. ab . sin	α Virginis (Spica)	IV	VI	—	*N*
14. zi . ba . ni . tum	α Librae	—	—	—	I
				with β, υ Scorpii	
15. gab . gír . tab	α Scorpii (Antares)	—	I	IV	—
16. PA . BIL . SAG	α Sagittarii (Alrami)	—	II	—	—
17. PA . BIL . SAG	ρ Sagittarii	V	—	—	II
18. suḫur . maš	α, β Capricorni	—	II	—	—
19. main star of IKU	β Pegasi (Scheat)	—	—	—	III
20. last star of IKU	γ Pegasi	VI	—	—	—
NORTHERN STARS					
21. šu . pa	α Bootis (Arcturus)	IV	VI	—	—
22. AN . GUB . BA	α Ophiuchi	—	—	—	4 days after II
23. našru	α Aquilae (Altair)	V	—	4 days after V	—
24. lu . lim	β Cassiopeiae (Schedar)	—	—	*N*	—
25. an . nu . ni . tum	β Andromedae (Mirach)	VI	—	—	—
26.	α Ceti	—	—	*N*	—

TABLE 4. *The Scheme of Intercalation*

Year*		Civil = Religious	Year		Civil	Year		Religious
1–119	I	Farvardīn	120	I	Farvardīn	120	I	Farvardīn
(1–115)	II	Ordībehešt	(116)		⋮	(116)		⋮
	III	Khordād			⋮			⋮
	IV	Tīr		XII	Esfendārmoḏ		XII	Esfendārmoḏ
	V	Mordād			Epagomenae			Epagomenae
	VI	Šahrīvar	121	I	Farvardīn	120	XIIa	Interc. Farvardīn II
			(117)			(116)		
	VII	Mehr			Epagomenae			Epagomenae
	VIII	Ābān		II	Ordībehešt	121	I	Farvardīn
						(117)		
	IX	Āḏār			⋮			⋮
	X	Dei			⋮			⋮
	XI	Bahman		XII	Esfendārmoḏ		XI	Bahman
	XII	Esfendārmoḏ	122–239	I	Farvardīn		XII	Esfendārmoḏ
			(118–231)					
		Epagomenae			Epagomenae			Epagomenae
				II	Ordībehešt	122–239	I	Farvardīn
					⋮	(118–231)		⋮
					⋮			⋮
				XII	Esfendārmoḏ		XI	Bahman
			240	I	Farvardīn		XII	Esfendārmoḏ
			(232)					
				II	Ordībehešt		XIIa	Interc. Farvardīn II
					Epagomenae			Epagomenae
				III	Khordād	240	I	Farvardīn
					⋮	(232)		⋮
					⋮			⋮
				XII	Esfendārmoḏ		X	Dei
			241–359	I	Farvardīn		XI	Bahman
			(233–347)					
				II	Ordībehešt		XII	Esfendārmoḏ
					Epagomenae			Epagomenae
				III	Khordād	241–359	I	Farvardīn
					⋮	(233–347)		⋮

* Year numbers in brackets refer to the Bīrūnian 116-year cycle.

TABLE 5. *Intercalation dates according to the 120- and 116-year cycles*

	Periods of 120 Persian years (43,800 days)			Periods of 116 Persian years (42,340 days)			
Period no.	Year no.	Date	Julian day*	Year no.	Date	Ruler	Julian day*
0	1	503 B.C., 27 March	1537 788	1	503 B.C., 27 March	Darius I, year 19	1537 788
1	121	383 B.C., 25 Feb.	1581 588	117	387 B.C., 26 Feb.	Artaxerxes II, year 18	1580 128
2	241	263 B.C., 26 Jan.	1625 388	233	271 B.C., 28 Jan.	Antiochus I Soter, year 11	1622 468
3	361	144 B.C., 27 Dec.	1669 188	349	156 B.C., 30 Dec.	Alexander Balas, year 2	1664 808
4	481	24 B.C., 27 Nov.	1712 988	465	40 B.C., 1 Dec.	Orodes (Arsaces XIV), year 16	1707 148
5	601	A.D. 97, 28 Oct.	1756 788	581	A.D. 77, 2 Nov.	Vologeses I (Arsaces XXIII), last year	1749 488
6	721	A.D. 217, 28 Sept.	1800 588	697	A.D. 193, 4 Oct.	Vologeses IV (Arsaces XXVIII), year 4	1791 828
7	841	A.D. 337, 29 Aug.	1844 388	813	A.D. 309, 5 Sept.	Hormisdas II, last year	1834 168
8	961	A.D. 457, 30 July	1888 188	929	A.D. *425*, 7 Aug.	Varahran V (Bahrāmgūr)	1876 508
9	1081	A.D. 577, 30 June	1931 988	1045	A.D. 541, 9 July	Khusrau Anōširvān, year 11	1918 848
10	1201	A.D. 697, 31 May	1975 788	1161	A.D. 657, 10 June		1961 188
11	1321	A.D. 817, 1 May	2019 588	1277	A.D. 773, 12 May		2003 528
12	1441	A.D. 937, 1 Apr.	2063 388	1393	A.D. 889, 13 Apr.		2045 868
13	1561	A.D. 1057, 2 March	2107 188	1509	A.D. *1005*, 15 March		2088 208
14	1681	A.D. 1177, 31 Jan.	2150 988	1625	A.D. 1121, 14 Feb.		2130 548

* See p. 765, n. 2.

TABLE 6. *The Thirty Day Names (for the Sogdian ones see p. 760, n. 2)*

	Avestan	Pahlavi	Modern Persian (Bīrūnī, p. 43, transl. 53)
1	Ahurahe Mazdā̊	Ohrmazd	Hormuz
2	Vaŋhave Manaŋhe	Vahman	Bahman
3	Ašahe vahištahe	Ardvahišt	Ordībehešt
4	Xšaθrahe vairyehe	Šahrēvar	Šahrīvar
5	Spəntayā̊ Ārmatōiš	Spandarmad	Esfendārmoḏ
6	Haurvatātō	Hordād	Khurdāḏ
7	Amərətātō	Amurdād	Murdāḏ
8	Daθušō	Dai pad Ādur	Dai-ba-Āḏar
9	Āθrō	Ādur	Āḏar
10	Apąm	Abān	Ābān
11	Hvarəxšaētahe	Xvar	Khūr
12	Mā̊ŋhahe	Māh	Māh
13	Tištryehe	Tīr	Tīr
14	Gə̄uš	Gōš	Gōš
15	Daθušō	Dai pad Mihr	Dai-ba-Mihr
16	Miθrahe	Mihr	Mihr
17	Sraošahe	Srōš	Srōš
18	Rašnaoš	Rašn	Rašn
19	Fravašinąm	Fravardīn	Farvardīn
20	Vərəθraγnahe	Vahrām	Bahrām
21	Rāmanō	Rām	Rām
22	Vātahe	Vād	Bāḏ
23	Daθušō	Dai pad Dēn	Dai-ba-Dīn
24	Daēnayā̊	Dēn	Dīn
25	Ašōiš	Ard	Ard
26	Arštātō	Aštād	Aštāḏ
27	Ašnō	Asmān	Āsmān
28	Zəmō hudā̊ŋhō	Zāmyād	Zāmyāḏ
29	Mąθrahe spəntahe	Mahrspand	Māraspand
30	Anaγranąm	Anagrān	Anīrān

BIBLIOGRAPHY

The abbreviations used in the bibliographies and footnotes are listed below.

AA	*Archäologischer Anzeiger* (Beiblatt zum Jahrbuch des deutschen archäologischen Instituts) (Berlin)
AAA	*Annals of Archaeology and Anthropology* (Liverpool)
AAntASH	*Acta antiqua academiae scientiarum Hungaricae* (Budapest)
AArchASH	*Acta archaeologica academiae scientiarum Hungaricae* (Budapest)
ABSA	*Annual of the British School at Athens*
Acta Iranica	Acta Iranica (encyclopédie permanente des études iraniennes) (Tehran-Liège-Leiden)
Aegyptus	*Aegyptus* 'Rivista Italiana di Egittologia e di Papirologia) (Milan)
AfO	*Archiv für Orientforschung* (Berlin)
AHM	I. Gershevitch, *The Avestan Hymn to Mithra* (Cambridge, 1959)
AION	*Annali: Istituto Orientale di Napoli* (s.l. sezione linguistica; n.s. new series) (Naples)
Air.Wb.	C. Bartholomae, *Altiranisches Wörterbuch* (Strassburg, 1904; 2nd ed. Berlin, 1961)
AJA	*American Journal of Archaeology* (Baltimore)
AJAH	*American Journal of Ancient History* (Cambridge, Mass.)
AJSLL	*American Journal of Semitic Languages and Literature* (Chicago)
AK	*Arkheologiya* (Kiev)
AMI	*Archäologische Mitteilungen aus Iran* (old series 9 vols 1929–38; new series 1968–) (Berlin)
Anatolia	*Anatolia/Anadolu* (revue annuelle d'archéologie) (Ankara)
Ancient Egypt	*Ancient Egypt (and the East)* (journal of the British School of Archaeology in Egypt) (London, 1914–35)
ANET	J. Pritchard, *Ancient Near Eastern Texts*, 3rd ed. (Princeton, N.J., 1969)
AnOr	*Analecta Orientalia* (Rome)
ANSMN	*American Numismatic Society Museum Notes* (New York)

ANSNNM	American Numismatic Society Numismatic Notes and Monographs (New York)
ANSNS	American Numismatic Society Numismatic Studies (New York)
Anthropos	*Anthropos* (International review of Ethnology and Linguistics) (Fribourg, Switzerland)
Antike Kunst	Halbjahresschrift herausgegeben von der Vereinigung der Freunde Antiker Kunst (Basle)
Antiquity	*Antiquity* (a periodical review of archaeology edited by Glyn Daniel) (Cambridge)
AOAW	*Anzeiger der Österreichischen Akademie der Wissenschaften* (Phil.-Hist. Klasse) (Vienna)
APAW	*Abhandlungen der Preussischen (Deutschen) Akademie der Wissenschaften* (Phil.-Hist. Klasse) (Berlin)
Archaeology	*Archaeology* (official publication of the Archaeological Institute of America) (New York)
ArOr	*Archiv Orientální* (Quarterly Journal of African, Asian and Latin American Studies) (Prague)
Artibus Asiae	*Artibus Asiae* (Institute of Fine Arts, New York Univesity) (Dresden, Ascona)
ASAE	*Annals du Service des Antiquités de l'Égypte* (Cairo)
ASE	*Arkheologicheskii Sbornik, Hermitage* (Leningrad)
Athenaeum	*Athenaeum* (Studi Periodici di Letteratura e Storia dell' Antichità; new series 1923–) (Pavia)
AU	*Arkheologiya Ukrainskoy RSR*, 2 vols (Kiev, 1971)
BA	*Beiträge zur Assyriologie* (Leipzig)
BASOR	*Bulletin of the American Schools of Oriental Research* (Baltimore, Maryland)
Berytus	*Berytus* (archaeological studies published by the Museum of Archaeology and the American University of Beirut) (Copenhagen)
BIFAO	*Bulletin de l'Institut francais d'archéologie orientale* (Cairo)
BiOr	*Bibliotheca Orientalis* (Leiden)
BMQ	*British Museum Quarterly* (London)
BSO(A)S	*Bulletin of the School of Oriental (and African) Studies* (University of London)
CAH	*The Cambridge Ancient History*, 12 vols; 1st edition Cambridge, 1924–39. Revised edition 1970–
CDAFI	*Cahiers de la Délégation archéologique française en Iran* (Paris)

CHI	*The Cambridge History of Iran*
Chiron	*Chiron* (Mitteilungen der Kommission für alte Geschichte und Epigraphik des Deutschen archäologischen Instituts) (Munich)
CIIr	*Corpus Inscriptionum Iranicarum* (London)
CIS	Corpus Inscriptionum Semiticarum (Paris)
CP	*Classical Philology* (Chicago)
CQ	*The Classical Quarterly* (new series) (Oxford)
CRAI	*Comptes rendus de l'Académie des inscriptions et belles lettres* (Paris)
Dacia	*Dacia* (Revue d'archéologie et d'histoire ancienne) (old series 1924–47; new series 1957–) (Bucharest)
DB	*The Behistun Inscription of Darius I*
East and West	*East and West* (Quarterly published by the Instituto Italiano per il Medio ed Estremo Oriente) (Rome)
Ex Oriente Lux	*Jaarbericht van het Vooraziatisch-Egyptisch Genootschop. Ex Oriente Lux* (Leiden)
Expedition	*Expedition* (The University Museum Magazine of Archaeology/Anthropology, University of Pennsylvania) (Philadelphia)
GJ	*The Geographical Journal* (London)
Greece and Rome	*Greece and Rome* (published for the Classical Association) (Oxford)
Hermes	*Hermes* (Zeitschrift für klassische Philologie) (Wiesbaden)
Hesperia	*Hesperia* (Journal of the American School of Classical Studies at Athens) (Princeton, N.J.)
Historia	*Historia* (Journal of Ancient History) (Wiesbaden)
HO	*Handbuch der Orientalistik*, ed. B. Supuler (Leiden–Cologne)
HSCP	*Harvard Studies in Classical Philology* (Cambridge, Mass.)
HUCA	*Hebrew Union College Annual* (Cincinnati)
GRBS	*Greek, Roman and Byzantine Studies* (Cambridge, Mass.)
IA	*Iranica Antiqua* (Leiden)
IG	*Inscriptiones Graecae* (Berlin 1873–)
IOS	*Israel Oriental Series* (Jerusalem)
Iran	*Iran* (journal of the British Institute of Persian Studies) (London–Tehran)
Iraq	*Iraq* (journal of the British School of Archaeology in Iraq) (London)

JA	*Journal Asiatique* (Paris)
JAOS	*Journal of the American Oriental Society* (New York)
JBL	*Journal of Biblical Literature* (Boston)
JCOI	*Journal of the K. R. Cama Oriental Institute*, 29 vols (Bombay, 1922–35)
JCS	*Journal of Cuneiform Studies* (New Haven, Conn.)
JEA	*Journal of Egyptian Archaeology* (London)
JHS	*Journal of Hellenic Studies* (London)
JNES	*Journal of Near Eastern Studies* (Chicago)
JSS	*Journal of Semitic Studies* (Manchester)
Klio	*Klio* (Beiträge zur Alten Geschichte) (Berlin)
KSIAK	*Kratkie Soobshcheniya Instituta Arkheologii* (Kiev)
KSIAM	*Kratkie Soobshcheniya Instituta Arkheologii* (Moscow)
KSIIMK	*Kratkie soobshcheniya o dokladakh i polevykh issledovaniyakh Instituta istorii materialnoi kultury AN SSR* (Moscow)
Kuml	*Kuml* (Aarbog for Jysk Arkaeologisk Selskab) (Aarhus)
KZ	*Zeitschrift für vergleichende Sprachforschung, begründet von Albert Kuhn* (Göttingen)
LCL	Loeb Classical Library (Cambridge, Mass.–London)
Levant	*Levant* (journal of the British School of Archaeology in Jerusalem) (London)
MASP	*Materialy po Arkheologii Severnovo Prichërnomoria* (Odessa)
MDAFA	Mémoires de la délégation archéologique française en Afghanistan (Paris)
MDAI	Mémoires de la Délégation archéologique en Iran (Paris)
MDOG	*Mitteilungen der Deutschen Orient-Gesellschaft* (Berlin)
MDP	*Mémoires de la Délégation en Perse* (Paris)
MIA	Materialy i Issledovaniya po Arkheologii SSSR (Moscow–Leningrad)
MMAB	*The Metropolitan Museum of Art Bulletin* (old series 1905–42; new series 1942–) (New York)
Le Muséon	*Le Muséon* (Revue d'Études Orientales) (Louvain–Paris)
NC	*Numismatic Chronicle* (London)
NTS	*Norsk Tidsskrift for Sprogvidenskap: Norwegien Journal of Linguistics* (Oslo)
Oriens	*Oriens* (journal of the International Society for Oriental Research) (Leiden)

Orientalia	*Orientalia* (a quarterly published by the Faculty of Ancient Oriental Studies, Pontifical Biblical Institute) new series (Rome)
OLZ	*Orientalische Literaturzeitung* (Berlin–Leipzig)
Paléorient	*Paléorient* (pluridisciplinary review of prehistory and protohistory of southwestern Asia) (Paris)
Pauly	Pauly, A. *Real-Encyclopädie der classischen Altertumswissenschaft*, ed. G. Wissowa (Stuttgart, 1894–)
PBA	*Proceedings of the British Academy* (London)
Persica	*Persica* (annuaire de la Société Néderlands-Iranienne) (Leiden)
PFT	R. T. Hallock, *Persepolis Fortification Tablets* (Chicago, 1969)
Philologus	*Philologus* (Zeitschrift für das classische Alterthum) (Göttingen–Leipzig–Berlin)
Phoenix	*Phoenix* (The Journal of the Classical Association of Canada) (Toronto)
PSBA	*Proceedings of the Society of Biblical Archaeology* (London)
PTT	G. G. Cameron, *The Persepolis Treasury Tablets* (Chicago, 1948)
RA	*Revue d'assyriologie et d'archéologie orientale* (Paris)
RAA	*Revue des arts asiatiques* (Paris)
RHR	*Revue de l'Histoire des Religions* (Paris)
RN	*Revue Numismatique* (Paris)
RSO	*Rivista degli Studi Orientali* (Rome)
RT	*Recueil de Travaux relatifs à la philologie et à l'archéologie égyptiennes et assyriennes* (Paris)
SA	*Sovetskaya Arkheologia* (Moscow)
SBE	Sacred Books of the East (Oxford)
SCBO	Scriptorum Classicorum Bibliotheca Oxoniensis (Oxford)
SCO	*Studi classici e orientali* (Pisa)
Semitica	*Semitica* (cahiers publiés par l'Institut d'études sémitiques) (Paris)
SPA	*A Survey of Persian Art*, ed. A. U. Pope and P. Ackerman, 6 vols (Text pp. 1–2817) (Oxford–London–New York, 1938–9); latest reprint 13 vols (Ashiya, Japan, 1981); vol. XIV *New Studies 1938–1960* (Text pp. 2879–3205) (Oxford–London, 1967); vol. XV *Biblio-*

	graphy of Pre-Islamic Persian Art to 1938 (cols 1–340), Reprint of *Index to Text Volumes I–III (i–vi)* (pp. 1–63) (Ashiya, Japan, 1977); vol. XVI *Bibliography of Islamic Persian Art to 1938* (cols 341–854) (Ashiya, Japan, 1977); vol. XVII *New Studies 1960–1973. In Memoriam Arthur Upham Pope, Part I Pre-Islamic Studies* (pp. 3207–3717) (not yet published); vol. XVIII *New Studies 1960–1973..., Part II Islamic Architecture* (not yet published); vol. XIX *New Studies 1960–1973..., Part III Islamic Art* (not yet published). References are given to page numbers only.
StIr	*Studia Iranica* (Leiden)
SVOD	Svod Arkheologicheskikh Istochnikov. Arkheologiya SSSR (Moscow)
Syria	*Syria* (Revue d'art oriental et d'archéologie) (Paris)
TPS	*Transactions of the Philological Society* (London)
TSBA	*Transactions of the Society of Biblical Archaeology* (London)
UE	*Ur Excavations. Reports* (Joint Expedition of the British Museum and of the University of Pennsylvania in Mesopotamia Publications) (London, 1927–)
UET	*Ur Excavations. Texts* (London, 1928–)
UGE	*J. Marquart, Untersuchungen zur Geschichte von Eran.* 2 vols. (Leipzig, 1905–6)
WO	*Die Welt des Orients* (Göttingen)
WZKM	*Wiener Zeitschrift für die Kunde des Morgenlandes* (Vienna)
YCS	*Yale Classical Studies* (New Haven, Conn.)
ZA	*Zeitschrift für Assyriologie* (Berlin)
ZAS	*Zeitschrift für Aegyptische Sprache* (Leipzig)
ZDMG	*Zeitschrift der deutschen morgenländischen Gesellschaft* (Wiesbaden)